RUNOFF, SEDIMENT TRANSPORT, AND WATER QUALITY IN A NORTHERN ILLINOIS AGRICULTURAL WATERSHED BEFORE URBAN DEVELOPMENT, 1979-81

By Howard E. Allen, Jr. and John R. Gray

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GLOSSARY

Antecedent discharge (Qwb). Stream discharge, in cubic feet per second (ft^3/s), 6 hours prior to commencement of storm runoff.

Drainage area (DA). An area from which surface runoff is carried away by a single drainage system. Also called watershed, drainage basin.

Maximum 30-minute rainfall intensity (R_{30}). The maximum recorded rainfall during a 30-minute interval, in inches per hour.

Mean storm discharge (Qwm). Storm runoff volume (Qwr) divided by storm runoff duration (D), in cubic feet per second (ft^3/s).

Mean suspended-sediment concentration (Cs). Discharge-weighted mean suspended-sediment concentration, in milligrams per liter (mg/L)

$$Cs = \frac{370.76\ (Qst)}{Qwr}.$$

Peak water discharge (Qwp). Instantaneous peak discharge, in cubic feet per second (ft^3/s).

Runoff. That part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage, or other works of man in or on the stream channels.

Storm runoff duration (D). The period of time, in days, from the initial increase in water discharge resulting from storm runoff until suspended-sediment concentrations correspond with pre-storm concentration values.

Storm runoff volume (Qwr). Total runoff (Qwt) minus the product of antecedent discharge (Qwb) times the storm runoff duration (D), in cubic feet per second-day [(ft^3/s)·d].

Storm suspended-sediment yield (Qst). Suspended sediment transported from a watershed passing a point of reference, such as a gaging station, during the storm runoff duration (D), in tons (tons/storm).

Suspended-sediment yield. Suspended sediment transported from a watershed passing a point of reference, in a specified period of time, such as a calandar year quarter, in tons (tons/mi^2, tons/acre).

Streamflow. The water discharge that occurs in a natural channel. The term streamflow may be applied to water discharge whether or not it is affected by diversion or regulation.

Suspended-sediment discharge (Qsr). Suspended-sediment discharge rate during storm runoff, in tons per day (tons/d).

Total precipitation (Rt). The arithmetic average depth of precipitation on a basin for a given storm.

Total runoff volume (Qwt). Total runoff during the period of storm runoff duration (D), in cubic feet per second-day [(ft^3/s)·d].

Water year. A continuous 12-month period from October 1 to September 30, for which streamflow data are compiled and reported.

FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM OF UNITS (SI)

For use of those readers who may prefer to use the International System of Units (SI), the factors for converting terms used in this report are listed below:

Multiply inch-pound units	By	To obtain SI units
inches (in.)	25.40	millimeters (mm)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)
acres	0.004047	square kilometers (km^2)
square miles (mi^2)	2.590	square kilometers (km^2)
tons, short	907.2	kilograms (kg)
tons, short	0.9072	megagrams (Mg)
inches per hour (in./h)	25.40	millimeters per hour (mm/h)
cubic feet per second (ft^3/s)	0.02832	cubic meters per second (m^3/s)
cubic feet per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meters per second per square kilometer [$(m^3/s)/km^2$]
cubic feet per second-day [$(ft^3/s) \cdot d$]	0.02832	cubic meters per second-day [$(m^3/s) \cdot d$]
tons per day (tons/d)	0.9072	megagrams per day (Mg/d)
tons per acre (tons/acre)	224.2	megagrams per square kilometer (Mg/km^2)
tons per square mile ($tons/mi^2$)	0.3503	megagrams per square kilometer (Mg/km^2)
miles per hour (mi/h)	1.609	kilometers per hour (km/h)
degrees Fahrenheit (°F)	°C = 5/9 (°F-32)	degrees Celsius (°C)

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from general adjustment of the first order level nets of both the United States and Canada, formerly called mean sea level.

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ABSTRACT

A study designed to quantify and evaluate changes in runoff and sediment transport attributable to construction activities during urban development of a watershed required the identification of pre-construction hydrologic conditions. Data collected before construction on a 2.81-square-mile agricultural watershed (upper Spring Creek) near Rockford, Illinois, show that during a 2-year period (July 1979 through June 1981), 2,890 tons of suspended sediment were transported from the watershed. Of the 2,890 tons, 2,690 tons or 93.1 percent were transported during a 46.6-hour period on June 13-14, 1981. Runoff from a 0.031-square-mile subbasin (Spring Creek tributary) during five storms transported 42.9 tons of suspended sediment, of which 33.9 tons were transported during a 3.2-hour period on June 13, 1981. Estimates of total sediment discharge indicate that sediment moving as bedload represented 2 percent or less of the total sediment discharged. Regression models relating storm suspended-sediment yields and peak-water discharge per square mile for Spring Creek and Spring Creek tributary have average standard errors of 57 and 24 percent, respectively. A relation between specific conductance and dissolved-solids concentrations has a standard error of 17.4 milligrams per liter, and provides a dependable means of estimating dissolved-solids concentrations from measurements of specific conductance. Trace amounts of currently banned pesticides, including Aldrin and DDT, were detected in streambed-material samples from Spring Creek. Documented sediment yields, chemical quality data, and relations between runoff and sediment discharge provide baseline information for future evaluation of hydrologic conditions in the Spring Creek watershed.

INTRODUCTION

Few data are available for assessing the runoff and sediment transport processes in northern Illinois agricultural basins. This report presents information relating to water and suspended-sediment discharges in the upper Spring Creek watershed, a 2.81-mi^2 (square mile) basin with principally agricultural land use, located northeast of Rockford in northern Illinois (fig. 1). The report documents precipitation, water and suspended-sediment discharges, water temperatures, specific-conductance values, and concentrations of selected constituents in samples of stream water and bed material during a period from April 1979 through June 1981. The data were collected before construction activities at sites on the upper Spring Creek watershed upstream and downstream from a planned residential development. Data on runoff and sediment transport also were collected from a 0.031-mi^2 subbasin located almost entirely within the area of the planned development (fig. 1).

The hydrologic data in this report will serve as baseline information for assessing changes in runoff and sediment transport processes which could result from construction of the planned development. The report also describes the general location, climate, physiography, geology, soils, land use, and land cover of the upper Spring Creek watershed.

STUDY AREA

Location

The study area is a 2.81-mi^2 drainage basin northeast of Rockford in the northern Illinois counties of Boone and Winnebago (fig. 1). The basin is drained by Spring Creek, which flows southwestward and empties into the Rock River in the central part of Rockford. The basin is bounded on the southwest by the campus of Rock Valley College and is nearly bisected by Interstate Highway 90 (Northwest Tollway).

The locations of hydrologic data-collection stations established for this study are shown in figure 2. Information characterizing each station is summarized in table 1.

Climate

The climate is humid continental, with warm to hot summers and fairly cold winters. The average annual temperature is 48°F, with average monthly temperatures ranging from 21°F in January to 70°F in July. The prevailing wind direction is south-southwest in the summer and predominantly northwest in the winter. Wind speeds average 10 miles per hour. The preceding data were obtained from the climatological data reports for Illinois (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1979-81).

The average annual precipitation at the Rockford Airport, about 10 miles southwest of the study basin, is 36.72 inches based on records collected by the U.S. Weather Service since 1950. Precipitation data collected during this study are presented in table 2 and in figure 3. Mean annual precipitation (arithmetic average from station records within the study area) from July 1979 through June 1981 was 4.35 inches (11.8 percent) less than the long-term average at the airport. The basin is subject to high-intensity rainstorms of short duration.

Physiography

The Spring Creek basin lies in the physiographic subdivision of the Rock River Hill Country (Leighton and others, 1948). The basin has a narrow elongated shape, rolling glaciated topography, and is typical of the surrounding area.

Altitudes in the basin range from 925 feet at the basin divide to 860 feet at the Rock Valley College gaging station. All altitudes in this report are referenced to the National Geodetic Vertical Datum of 1929. The channel of Spring Creek has a fairly uniform gradient of about 0.25 percent. Ridges flanking the narrow valley are 30 to 40 feet above the streambed. Land-surface slopes in the basin average 2 percent.

A topographic map of the Spring Creek tributary basin is shown in figure 4. The principal waterway in the tributary basin has a gradient of 2.0 percent. Land-surface slopes in the tributary basin average 2.9 percent.

Geology and Soils

Surficial deposits, resulting from glaciation during the Pleistocene Epoch, range in thickness from 40 to 150 feet over the bedrock in the upper Spring Creek watershed (Berg and others, 1981). The dominant bedrock is dolomite of the Galena Dolomite, Decorah Formation and Platteville Formation of Ordovician age.

Most soils in the upper Spring Creek watershed are formed in a loess mantle, which varies in thickness from 1 to 5 feet, and in the underlying glacial outwash and till. Alluvial soils and soils formed in eolian sands are also found in the watershed. The dolomitic bedrock does not serve as a parent material for soils in the Spring Creek study area (U.S. Department of Agriculture, Soil Conservation Service, 1980).

Soil surveys by the U.S. Department of Agriculture, Soil Conservation Service (1980) describe 26 soil series in the upper Spring Creek watershed. The U.S. Department of Agriculture has assigned a unique mapping unit designation to each phase of a soil series which identifies the soil by series name, surface texture, land slope, and erosion class. Mapping unit numbers identifying each soil are provided in table 3.

Individual soil series were categorized, with the assistance of Dennis McKenna, Executive Director of the Winnebago County Soil and Water Conservation District, into five erosion-potential groups rated as none, slight, moderate, severe, and very severe. The method used to rate erosion-potential groups utilized topography and soil erodibility (K factor) as described by Wischmeier, Smith, and Ohland (1958). An erosion-potential rate of none was assigned to those areas experiencing depositional gains of eroded material.

Table 3 shows each soil series grouped according to its soil erosion potential and other pertinent soil characteristics. Areal distribution of erosion-potential groups is shown in figure 5.

Land Use and Land Cover

Land use and land cover in the watershed (table 4) were determined from aerial photographs taken in 1979. A field reconnaissance in June 1981 indicated no significant change in land use and land cover since 1979.

The primary land use in the watershed is agricultural, characterized by about 88 percent cultivated fields, the majority of which are in row crops. Corn is the major crop, frequently rotated with soybeans.

A small residential development (48 acres) is located just north of Spring Brook Road and 0.25 mile east of McFarland Road (fig. 2). The remainder of the area designated as residential (34 acres) is comprised of scattered farm homesteads.

STREAMFLOW

Streamflow in the Spring Creek basin is dependent on rainfall, snowmelt, water infiltration, soil moisture, and ground-water levels. High flows that occur from late spring to fall usually result from high-intensity rainstorms. High flows occurring during late winter and early spring usually result from snowmelt runoff over frozen soil. Evapotranspiration reduces the amount of available water infiltrating to the water table during the growing season and, concomitant with ground-water discharge, results in a decline of ground-water levels and a subsequent decrease in the stream's base flow. The base flow and ground-water levels increase during the fall due to the decrease in evapotranspiration that accompanies vegetative senescence.

A continuous record of the water level (stage) was obtained by water-stage recorders at the two gaging stations on Spring Creek (fig. 2). Stage-discharge relations, defined by making discharge measurements at various stages, were used to compute water discharge at the two gaging stations.

Monthly and annual (October 1 to September 30) water and suspended-sediment discharges at the Spring Creek gaging stations are tabulated in table 5. Mean-daily discharges along with other records of streamflow are published in the annual water resources data reports for Illinois (U.S. Geological Survey, 1981, 1982).

Water discharge at the Spring Creek tributary station was computed by using a Parshall flume rating and recorded water stage. Streamflow in this watershed is ephemeral.

Crest-stage gages at the partial-record station on Spring Creek near Argyle recorded the highest stage that occurred during each interval between field inspections. Peak discharges corresponding to recorded peak stages were obtained from a stage-discharge relation defined by discharge measurements and techniques described by Hulsing (1967) and Bodhaine (1968).

Storm-runoff rates, instantaneous peak discharges, and other storm related hydrologic characteristics for sites in the upper Spring Creek basin are presented in table 6.

Total runoff from the upper Spring Creek watershed from July 1979 through June 1981 was 14.88 inches. The total precipitation (an arithmetic average of the values for three precipitation stations within the watershed) during the same period was 64.74 inches (table 2). Variations in monthly precipitation and runoff at the Rock Valley College gaging station are shown in figure 6. Monthly runoff ranged from 0.03 inches in October 1979 to 3.17 inches in June 1981.

The maximum storm runoff from the basin, 2.51 inches of runoff in a 46.6-hour period, occurred on June 13-14, 1981. The peak discharge of 623 ft^3/s (cubic feet per second) on June 13, 1981, at the Rock Valley College gaging station, exceeded the 1-percent probability flood discharge of 540 ft^3/s estimated by using techniques described by Curtis (1977, p. 2).

SEDIMENT

The total sediment discharge of a stream has two principal components: (1) suspended-sediment discharge--that sediment in transport which is maintained in the flow by the upward components of turbulent currents or by colloidal suspension, and (2) bedload discharge, which consists of that sediment transported by sliding, rolling, or skipping very close to the streambed. Only suspended-sediment discharges were measured during this study.

Sediment Sources

Fluvial sedimentation includes the processes of erosion, transport, and deposition of soil particles or rock fragments. Most of the sediment transported by a stream is the result of upland sheet erosion or channel erosion, although the relative importance of the two sources has not been clearly defined (Colby, 1963).

The quantity of soil removed by sheet erosion varies with such factors as surface slope, precipitation intensity and raindrop size, antecedent soil moisture, soil type, and vegetative cover (Guy, 1970). Cultivated fields, which compose 88 percent (1,583 acres of a total 1,798 acres) of the study basin, represent a potentially large source of sediment from sheet erosion. These fields are particularly vulnerable to erosion during crop planting or in the early growing season when the land is almost devoid of vegetative cover.

Field inspections of Spring Creek's meandering channel and high-cut banks suggest that a substantial amount of sediment discharge results from channel erosion.

Data Collection

Water-sediment samples for determination of suspended-sediment concentration and particle-size distribution at the McFarland Road and Rock Valley College gaging stations were collected automatically by pumping samplers (US PS-69, with intakes at fixed points in the stream), manually using depth-integrating samplers (US DH-48 and US DH-76), and by dip sampling during periods of extreme low flow. The pumping samplers at these stations were set to obtain samples every 22.5 minutes during storm runoff in addition to daily samples. Manually collected discharge-weighted samples were obtained simultaneously with pumped samples during several runoff periods to establish a relation between the suspended-sediment concentration at the pumping-sampler intake and concentration of the stream cross section. Coefficients defined by these relations were applied to the concentrations obtained from the pumped samples to define the cross-sectional concentration. Manually collected samples were also used to supplement the pumped samples during storm runoff.

Water-sediment samples at the Spring Creek tributary station were collected at 5-minute intervals during storm runoff by a Manning S-4050 pumping sampler.[1]

An assembly of single-stage samplers (US U-59) mounted with vertical spacing ranging from 7 to 10 inches was used to collect water-sediment samples automatically on the rising phase of storm runoff at all gaging stations.

Representative samples for determination of bed material particle-size distribution were collected along a reach of the channel near each gage by using a bed-material sampler (US BMH-53). These data were used in estimating total sediment discharge.

Sediment samplers, data collection methods, and analyses techniques used for the determination of suspended-sediment concentrations and computation of sediment discharge in this report are described by Guy and Norman (1970), Porterfield (1972), Vanoni and others (1975), and Department of Agriculture, Science and Education Administration (1979).

Suspended Sediment

Size Distribution of Suspended Sediment

The size distribution of suspended sediment transported by a stream is an indicator of the sediment parent material and the ability of the stream to move sediment.

The particle-size distribution of suspended sediment at the Rock Valley College station was determined for 19 samples collected at instantaneous water discharges ranging from 0.82 to 284 ft^3/s (table 7). The suspended sediment at this station is composed almost entirely of silt- and clay-size particles (<0.062 mm). Except for the particle-size distributions determined for two February 22, 1981, samples, all samples showed at least 96 percent silt- and clay-size particles. Four of the size-distribution determinations at instantaneous water discharges ranging from 21 to 284 ft^3/s indicated ranges of 48 to 84 percent for clay-size particles and 16 to 51 percent for silt-size particles.

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[1] The use of the brand name in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

The particle-size distribution of suspended sediment at the Spring Creek tributary station was determined for 10 samples collected at water discharges ranging from 0.60 to 38.0 ft^3/s (table 7). Figure 7 shows the relation of the sand-, silt-, and clay-size fractions of suspended sediment to water discharge at the tributary station. Variations in the sand-size percentage were relatively small compared to those for silt- and clay-size. Increases in water discharge were generally accompanied by increases in the silt-size fraction and declines in the clay-size fraction of the suspended sediment.

Suspended-sediment data for the Spring Creek station near Argyle represent five water-sediment samples collected from storm runoff on June 13, 1981. Particle-size analyses of these samples, representing instantaneous water discharges ranging from 7.6 to 204 ft^3/s, indicated silt- and clay-size particles made up 99 to 100 percent of the suspended sediment (table 7).

Suspended-Sediment Discharge

Annual and monthly suspended-sediment discharges at the McFarland Road and Rock Valley College gaging stations are summarized in table 5. Daily suspended-sediment discharges computed for these stations are published in the annual water resources data reports for Illinois (U.S. Geological Survey, 1981, 1982). Suspended-sediment discharge resulting from storm runoff and other related storm factors are listed in table 6.

From July 1979 through June 1981, 2,890 tons of suspended sediment from the upper Spring Creek watershed were transported past the Rock Valley College gaging station. Suspended-sediment transported past the McFarland Road station during the same period was 2,490 tons, or 86.2 percent of that at the Rock Valley College station. Ten storms, representing a combined 11.7 days or 1.6 percent of the 2-year period, produced 97.6 percent of the total suspended-sediment load from the basin. Most of this, 2,690 tons or 93.1 percent, was transported during a 46.6-hour period on June 13-14, 1981. Suspended-sediment loads transported during storm and nonstorm periods are summarized in table 8.

The runoff from the Spring Creek tributary basin during five storms transported 42.9 tons of suspended sediment, 33.9 tons (79 percent) of which were transported during a 3.2-hour period on June 13, 1981 (table 6).

Graphical relations between suspended-sediment concentration and water discharge were developed for the period of record for each of the continuous-record gaging stations. These relations were used to estimate sediment discharge during periods of missing data. Average concentration curves for the study period are shown in figures 8 and 9 for the Rock Valley College and Spring Creek tributary gaging stations.

The relation of suspended-sediment concentration to water discharge for three storms at the Rock Valley College gaging station are shown in figure 8. The June 7-8, 1980, and September 12-13, 1980, curves describe low-intensity storm runoff periods, while the June 13-14, 1981, curve describes a high-intensity runoff period (U.S. Department of Agriculture, Science and Education Administration, 1979, p. 346).

Figure 9 shows the relation of suspended-sediment concentration to water discharge developed for the June 7, 1980, and June 13, 1981, storms at the Spring Creek tributary gaging station. No measurable runoff from the tributary watershed occurred as a result of the September 13, 1980, rainstorm.

The feasibility of predicting long-term suspended-sediment yields from the upper Spring Creek watershed by using a mean suspended-sediment transport curve in conjunction with a flow-duration curve was investigated. Although mean suspended-sediment transport curves were defined, the brevity of the period of streamflow record (2 years) and the lack of a representative surface-water index station for use in synthesis of a flow-duration curve (Mitchell, 1957, p. 6-18), precluded the development of a useful flow-duration curve.

Typical storm hydrographs of water discharge, suspended-sediment discharge, and precipitation are shown in figures 10-12. These hydrographs represent storms occurring on June 7, 1980, September 12-13, 1980, and June 13, 1981, at the Rock Valley College gaging station and on June 7, 1980, and June 13, 1981, at the Spring Creek tributary station. The storm hydrographs show temporal variations in water and suspended-sediment discharges.

Variability of Suspended-Sediment Discharge

Variations in suspended-sediment discharge from a watershed often occur from year to year, season to season, and storm to storm. Some factors which influence these variations are rainfall amount and intensity, antecedent soil moisture, temperature, tillage practices and vegetative cover (Guy, 1964, Jones, 1966, and Yorke and Herb, 1978). Because many of the variables affecting sediment transport and yield are interrelated, the quantitative influence of any specific variable is difficult to determine. In the upper Spring Creek watershed, extensive changes in vegetative cover during the year may be one of the dominant factors affecting seasonal variability of suspended-sediment discharges.

The quarterly suspended-sediment yields shown in table 9 indicate the seasonal variability of suspended-sediment loads transported in Spring Creek. The highest quarterly-mean yield (491.31 tons/mi^2) occurred during the second calendar-year quarter (April-June, 1980-81) resulting from the large volume of rainfall and runoff (fig. 6) during the planting seasons. In contrast, the lowest yield (2.11 tons/mi^2) occurred during the fourth quarter (October-December, 1979-80).

Regression Analysis

Stepwise linear-regression analyses (Helwig and Council, 1979) were used to quantify the effects of storm-related variables (listed in table 6) on storm suspended-sediment yields (Qst) for each gaging station to establish runoff-sediment yield conditions preceding construction of the planned development. Correlation analyses showed peak-water discharge (Qwp) to be the most significant independent variable. Adding other independent variables to the regression analyses did not appreciably increase correlation coefficients or reduce standard errors (SE) from those indicated by simple linear regressions.

In an effort to define a functional relation and to fit regression lines better to the data, the values of peak discharge (Qwp) and storm suspended-sediment yields (Qst) were divided by the corresponding drainage area for each station to adjust the data for basin size. Common logarithms of storm suspended-sediment yields in tons per square mile (Qst/DA) and peak-water discharges in cubic feet per second per square mile (Qwp/DA) were used in the analyses.

Satisfactory relations could not be defined when the data for the Spring Creek tributary watershed were combined with the data for Rock Valley College and McFarland Road watersheds. Therefore, two separate regression analyses were performed, one on data for the two larger watersheds and one on data from the tributary watershed. These regression equations were developed to quantify the relation between peak-water discharge per square mile and suspended-sediment yield per square mile for these watersheds before urban development. Similar analyses of these variables will be made during and after development for evaluation of impacts. The use of these equations to estimate sediment yields at other locations should be restricted to locations with similar watershed characteristics and, even then, should be used only to provide gross estimates.

The relation between storm suspended-sediment yield (Qst/DA) and peak-water discharge per square mile (Qwp/DA) based on the combined data for the gaging stations at Rock Valley College and at McFarland Road (table 6) is shown in figure 13. The regression model was defined by the least-squares method and has an average standard error of 57 percent, a correlation coefficient of 0.98, and can be expressed as:

$$Qst/DA = 0.076\ (Qwp/DA)^{1.755},$$

where Qst/DA = the amount of suspended sediment transported by storm runoff, in tons, divided by the drainage area of the watershed, in square miles.

Qwp/DA = instantaneous peak-water discharge, in cubic feet per second, divided by the drainage area of the watershed, in square miles.

Figure 14 shows the relation between storm suspended-sediment yield (Qst/DA) and peak-water discharge per square mile (Qwp/DA) based on the data for the Spring Creek tributary station. The regression model was defined by the least-squares method and has an average standard error of 24 percent, a correlation coefficient of 0.99, and can be expressed as:

$$Qst/DA = 0.119\ (Qwp/DA)^{1.178}.$$

Field observations immediately after storm runoff indicate that delivery of sediment from the subbasin to Spring Creek is often reduced to zero. This is primarily due to differences in basin characteristics which occur in the part of the subbasin downstream from the tributary gaging station. These differences include decreased channel slope, depression storage, and increased roughness due to dense vegetative cover along Spring Creek. Therefore, the subbasin storm sediment yield equation should not be used to predict sediment delivery to Spring Creek. The relation for the subbasin was developed primarily to describe storm suspended-sediment yields from the subbasin prior to construction of the urban development.

Bedload Contribution

Bedload discharge was not measured directly during this study. Depth-integrating water-sediment samplers currently approved by the U.S. Geological Survey can collect a water-sediment mixture from all but the lower 0.3 to 0.4 foot of the water column. Sediment transported as bedload in this unsampled zone can be approximated by special sampling techniques or by solution of complex formulas.

Total sediment discharges were estimated at the Rock Valley College gaging station using computational methods described by Colby and Hubbell (1962). Estimates of total sediment discharges were computed using water-discharge measurements ranging from 81 to 284 ft^3/s and particle-size distribution of bed material as published in the annual water resources data report for Illinois (U.S. Geological Survey, 1981, p. 273). The differences between measured suspended-sediment discharges and estimated total sediment discharges indicate that the unmeasured bedload discharge is probably no more than 2 percent of the total sediment discharge from the watershed.

Sediment data in this report pertain to suspended sediment only. No adjustments have been made to account for sediment transported as bedload.

CHEMICAL AND PHYSICAL CHARACTERISTICS

Data Collection

Water temperature and specific conductance were monitored continuously at the Rock Valley College and McFarland Road gaging stations. Measurements of temperature and specific conductance were made in situ with portable instruments to calibrate the monitors and verify the recorded data.

Daily records of water temperature and specific conductance at the two gaging stations are published in the annual water resources data reports for Illinois (U.S. Geological Survey, 1981, 1982).

Stream-water and bottom-material samples for selected chemical and physical analyses were collected at various flow conditions from April 1979 through June 1981. Samples were collected by using the techniques previously described for sediment data collection. Bottom-material samples were collected along the streambed within short distances upstream and downstream from Interstate Highway 90 (fig. 2) and near the Rock Valley College and McFarland Road gaging stations.

Water Temperature

Water temperature has a direct influence on the quality of water for domestic supplies, fisheries and wildlife, biochemical degradation of wastes, and industrial and agricultural uses (Stevens and others, 1975). Water temperatures are also used to help compute total sediment discharge and to identify periods when streamflow may be affected by backwater from ice in the stream channel.

The monthly and annual maximum, minimum, and mean values of water temperatures of Spring Creek recorded at the McFarland Road and Rock Valley College gaging stations are summarized in table 10. Water temperatures measured at the gaging stations ranged from 0°C to 32.0°C. The 0°C temperatures occurred on many days during the winter period. Maximum temperatures commonly coincided with periods of low flow and high ambient air temperatures.

Specific Conductance and Dissolved Solids

Specific conductance is a measure of the ability of water to conduct an electric current and is reported as micromhos (μmho) per centimeter at 25°C. As the concentrations of dissolved solids in water increase, the specific conductance of the water also increases.

The monthly and annual maximum, minimum, and mean values of specific conductance recorded at the McFarland Road and Rock Valley College gaging stations are summarized in table 10. Observed instantaneous values of specific conductance ranged from 75 to 2,560 μmhos at McFarland Road and 65 to 1,460 μmhos at Rock Valley College. Minimum specific conductance values occurred during storm runoff reflecting the dilution effect of direct rainfall runoff. Maximum values were recorded during the periods of low flow and snowmelt runoff.

A relation between specific conductance and dissolved-solids concentrations was defined for Spring Creek at the Rock Valley College gaging station (fig. 15). The relation was based on analyses of 23 water samples collected over a range of water discharges from 0.75 to 168 ft^3/s (table 11). Specific conductance of the samples ranged from 104 to 740 μmhos and the dissolved-solids concentrations ranged from 84 to 502 mg/L. The relation has a correlation coefficient of 0.99 and a standard error of estimate of 17.4 mg/L. The analysis demonstrates that, in the range of specific conductance from 100 to 800 μmhos and dissolved-solids concentrations from 60 to 500 mg/L, instream specific-conductance values are reliable indicators of dissolved-solids concentrations in Spring Creek.

Stream Water and Streambed Material Chemical Analyses

Some chemicals associated with streambed material may be used as historical indicators of a stream's water quality. Trace amounts of currently banned pesticides, including Aldrin and DDT, were detected during chemical analyses of bottom-material samples from Spring Creek.

High counts of fecal coliform bacteria and fecal streptococcal bacteria were determined from water samples collected on April 26, 1979. Ratios of fecal coliform to fecal streptococci (less than 0.02) suggest that the bacteria source was nonhuman (Geldreich, 1976).

Chemical analyses of stream-water and streambed-material samples collected during this study are given in table 11.

SUMMARY

This report summarizes hydrologic conditions, including runoff, sediment transport, chemical and physical water-quality characteristics, before urban construction in the upper Spring Creek watershed, a 2.81-mi^2 agricultural basin near Rockford, Ill. The summary of pre-construction conditions are based on hydrologic data collected at four gaging stations and three recording precipitation stations from April 1979 through June 1981.

The study basin is typical of the surrounding area with a narrow elongated shape, rolling glaciated topography, and an average land slope of 2 percent. Topography of a small subbasin (0.031 mi^2), Spring Creek tributary, was mapped at a 2-foot contour interval. This subbasin is situated almost entirely within the area of a planned residential development.

Most soils in the basin are formed in a loess mantle and in the underlying glacial outwash and till. Soils of the basin were categorized into five erosion-potential groups rated as none, slight, moderate, severe, and very severe. The land use remained fairly constant during the study period with cultivated fields comprising the major portion (88 percent) of the basin.

The mean annual precipitation during the period from July 1979 through June 1981 was 4.35 inches (11.8 percent) lower than the long-term average compiled from records at the Rockford Airport. Monthly runoff ranged from 0.03 inches in October 1979 to 3.17 inches in June 1981. The largest storm runoff from the basin, 2.51 inches in a 46.6-hour period, occurred on June 13-14, 1981. The peak discharge of 623 ft^3/s on June 13, 1981, at the Rock Valley College gaging station, exceeded the estimated 1-percent probability flood discharge of 540 ft^3/s.

During the period July 1979 through June 1981, 2,890 tons of suspended sediment were transported from the upper Spring Creek basin. Ten storm periods accounted for 97.6 percent of the total suspended-sediment load in a combined 11.7 days, or 1.6 percent of the period. The storm runoff of June 13-14, 1981, transported 93.1 percent (2,690 tons) of the total suspended-sediment load in a 46.6-hour period.

Runoff from Spring Creek tributary during five storms transported 42.9 tons of suspended sediment, of which 33.9 tons or 79 percent were discharged during a 3.2-hour period on June 13, 1981.

Storm suspended-sediment yields in tons per square mile and corresponding peak-water discharges in cubic feet per second per square mile were related by simple linear regression. Relations based on data from the gaging stations at Rock Valley College and McFarland Road and from the tributary station had average standard errors of 57 and 24 percent, respectively. Adding selected storm related independent variables to the regression analyses did not appreciably increase correlation coefficients or reduce standard errors over those indicated by simple linear regressions.

Estimates of total sediment discharges from the upper Spring Creek watershed indicated that sediment transported as bedload is probably no more than 2 percent of the total sediment discharged from the watershed.

Relations between specific conductance and dissolved-solids concentrations demonstrate that instream specific conductance may be used as a reliable indicator of dissolved-solids concentrations in Spring Creek. Trace amounts of currently banned pesticides, including Aldrin and DDT, were detected in streambed-material samples from Spring Creek.

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FIGURES 1-15; TABLES 1-11

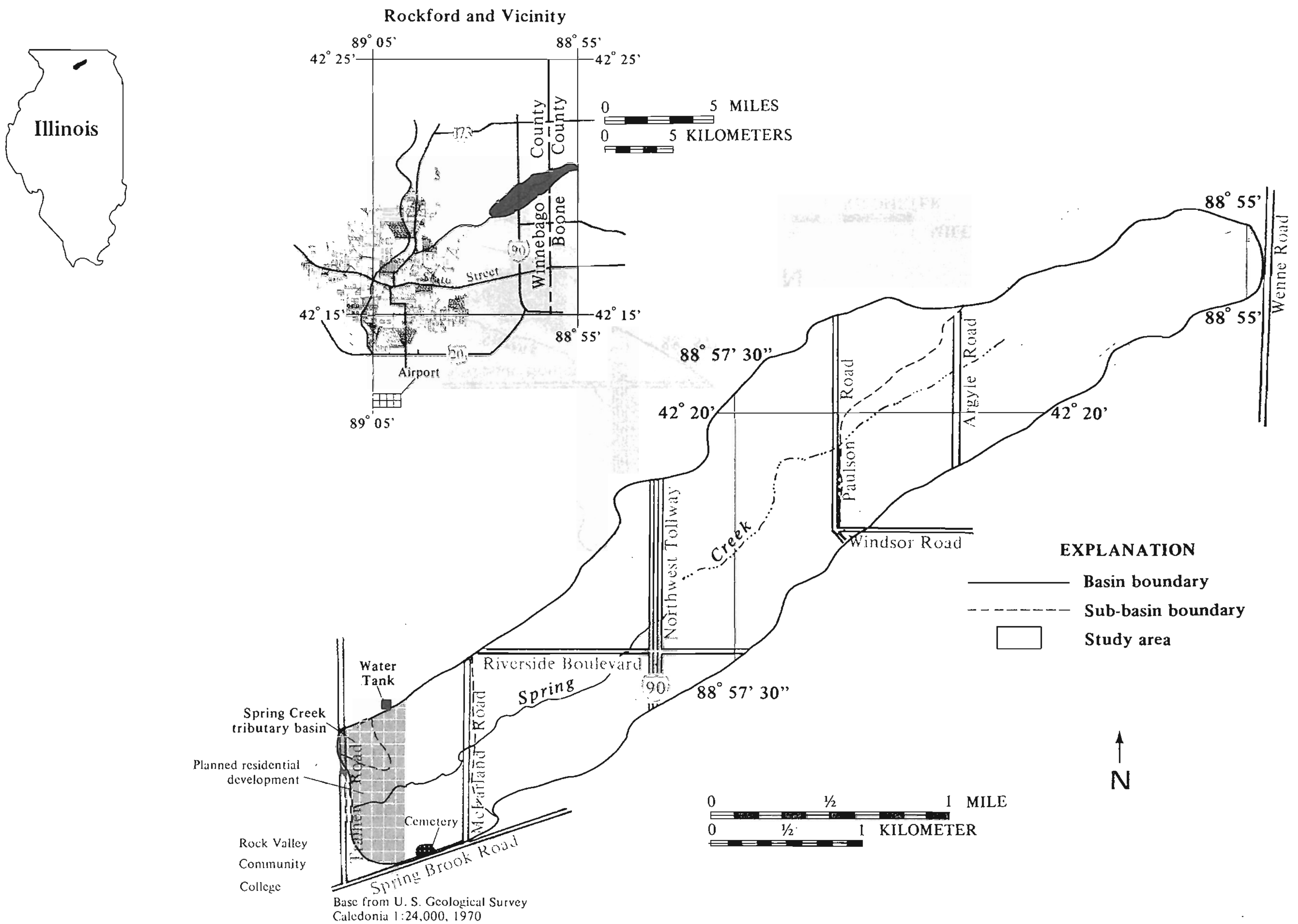

Figure 1. Location of the upper Spring Creek watershed.

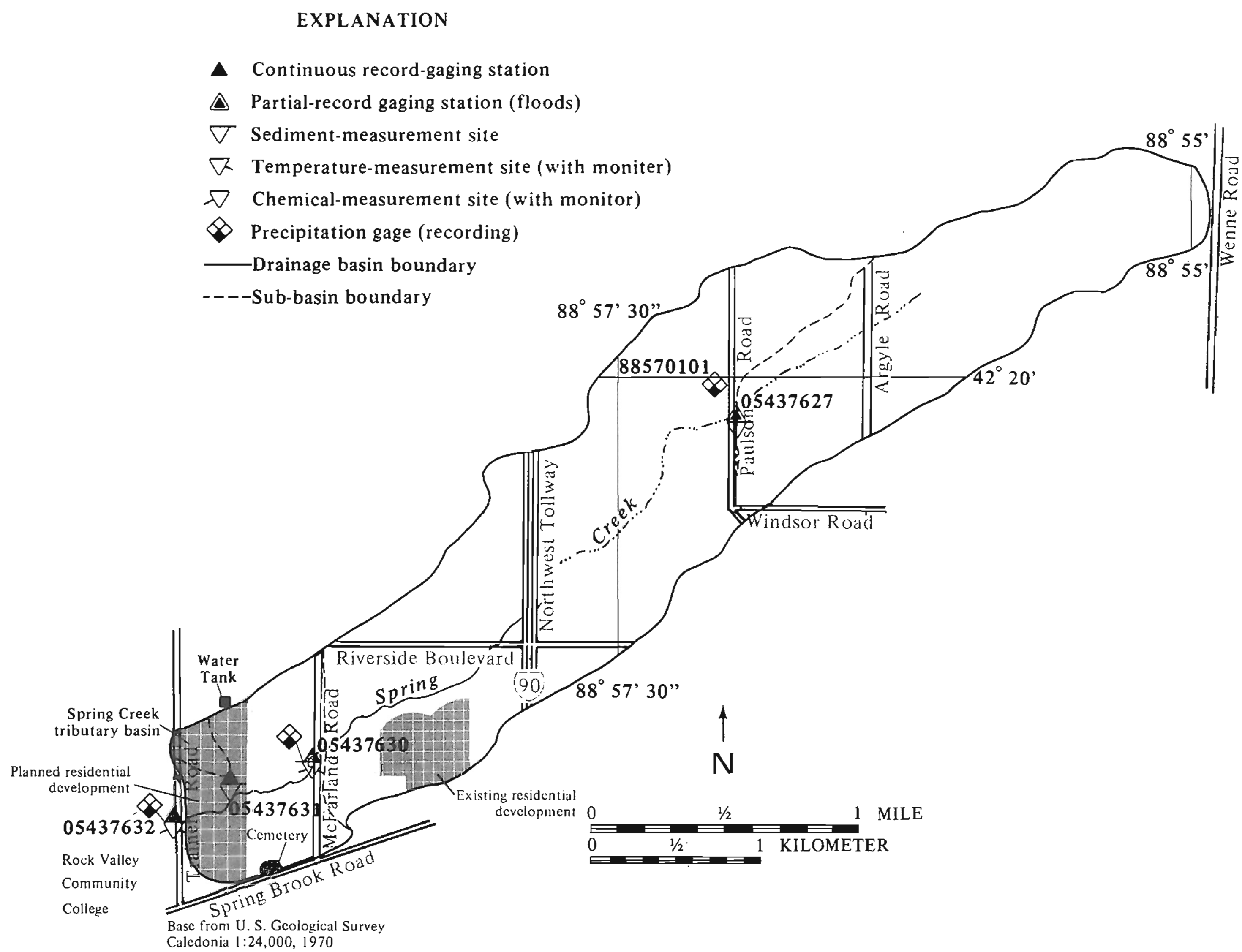

Figure 2. Hydrologic-data stations in the upper Spring Creek watershed.

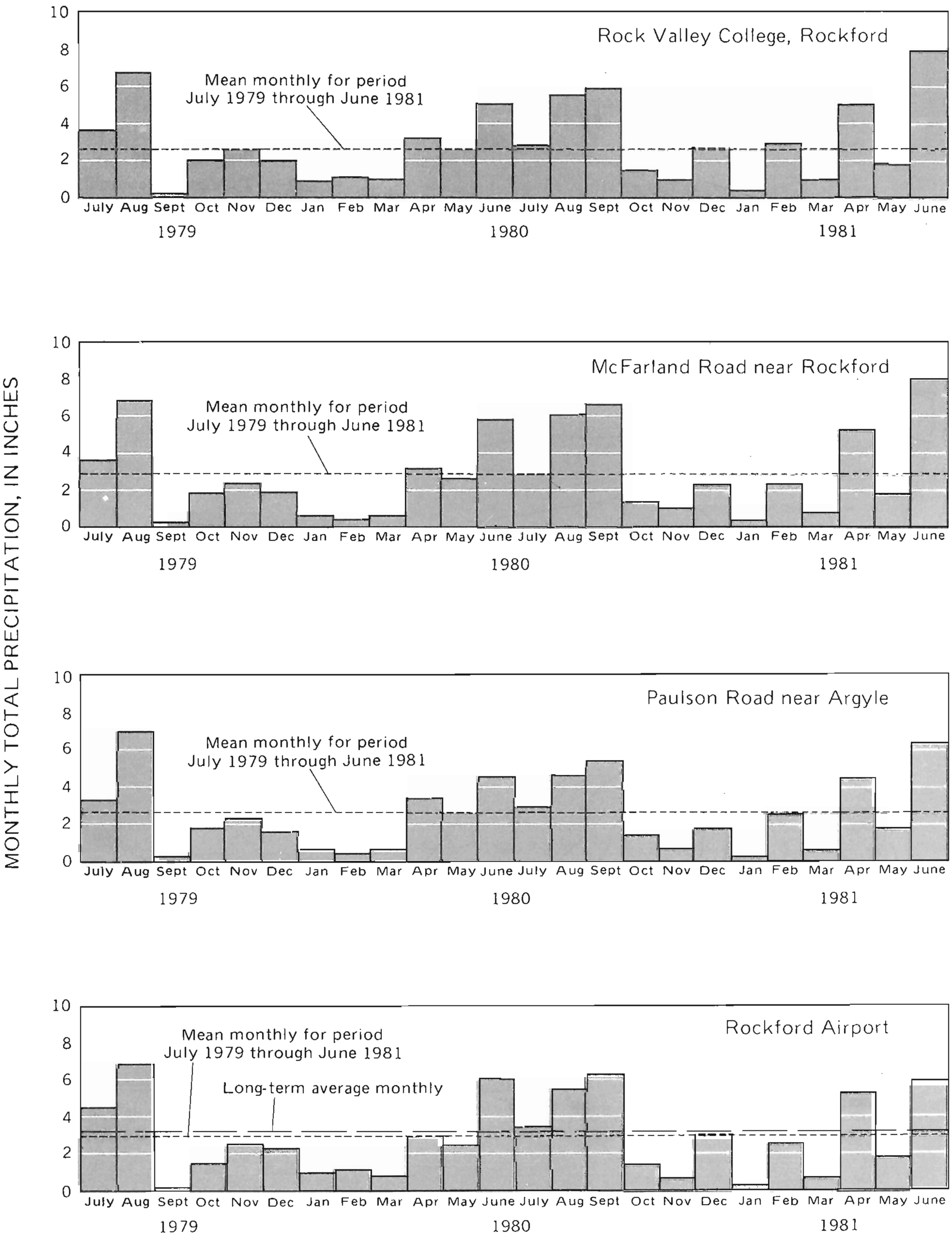

Figure 3. Monthly precipitation in the vicinity of the upper Spring Creek watershed, July 1979 through June 1981.

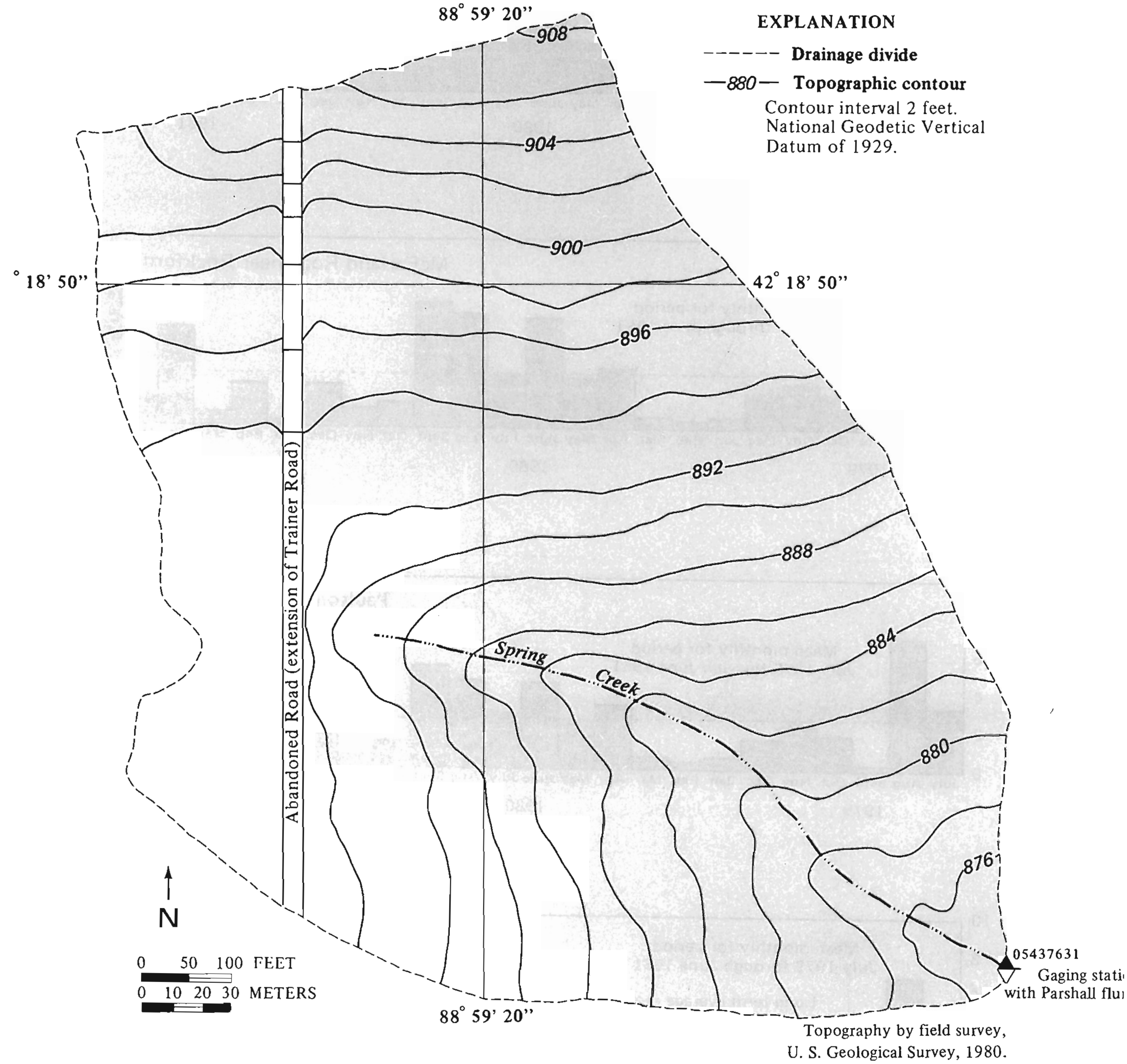

Figure 4. Topographic map of the Spring Creek tributary watershed.

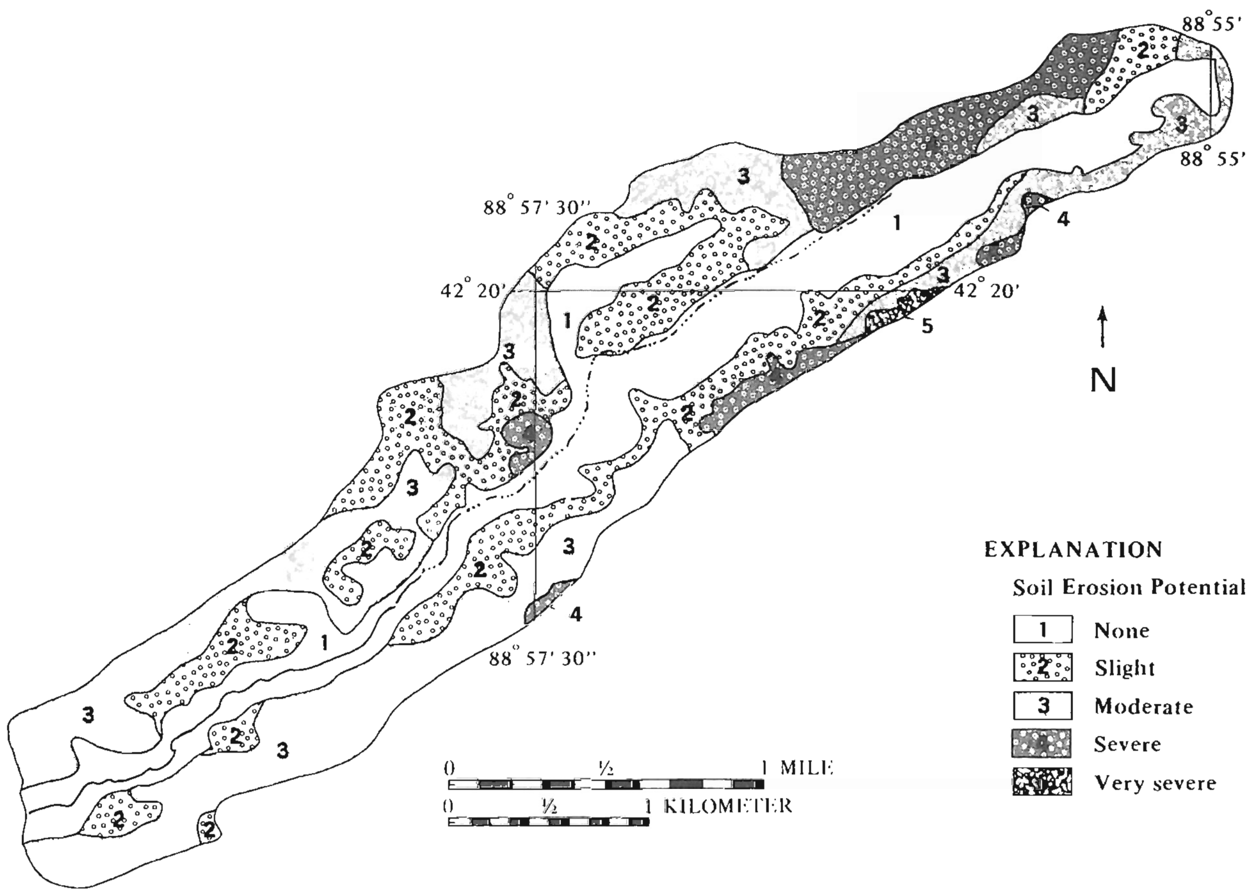

Figure 5. Areal distribution of erosion-potential groups in upper Spring Creek watershed.

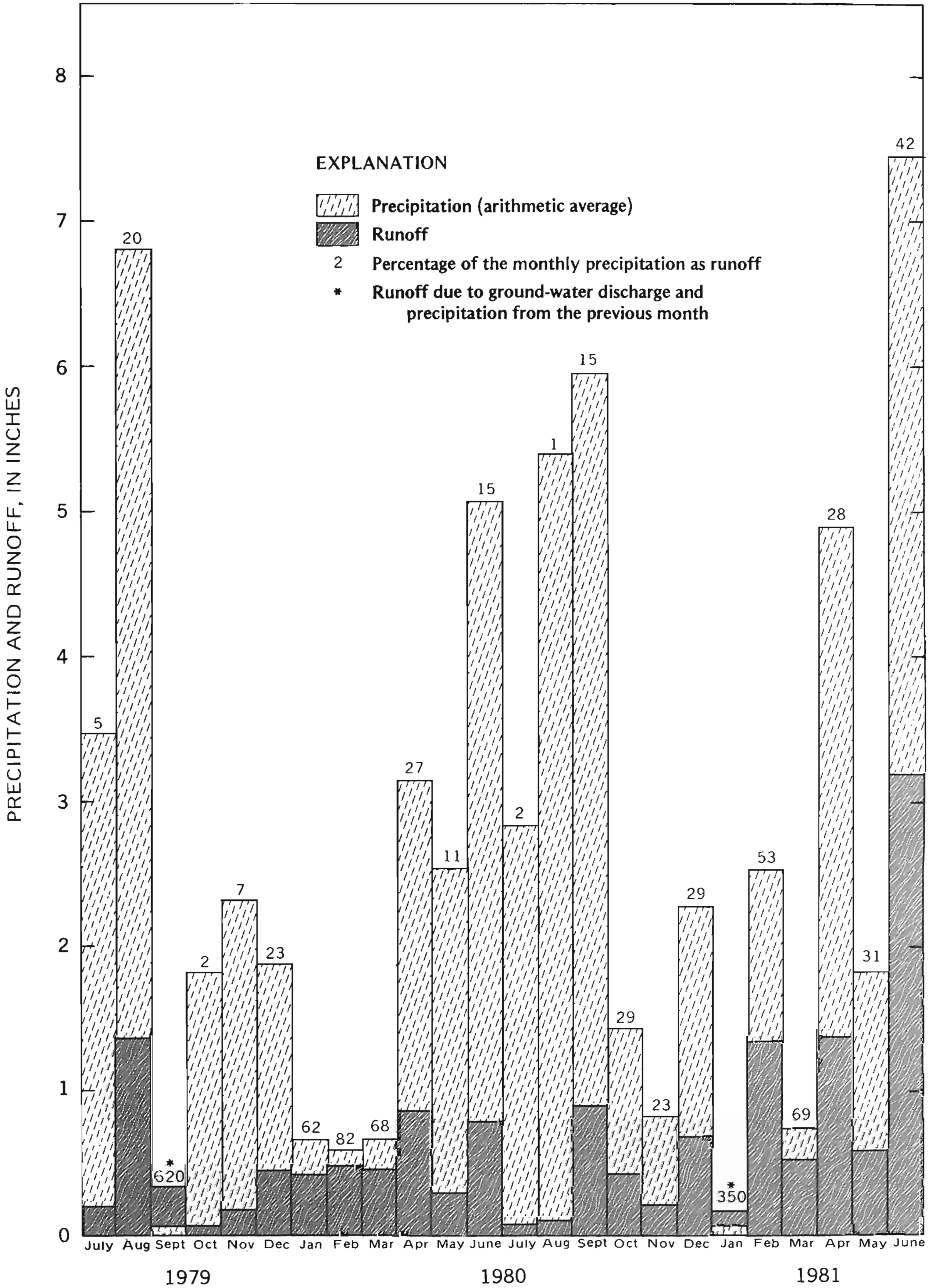

Figure 6. Variation in monthly precipitation and runoff, Spring Creek at Rock Valley College, Rockford, July 1979 through June 1981.

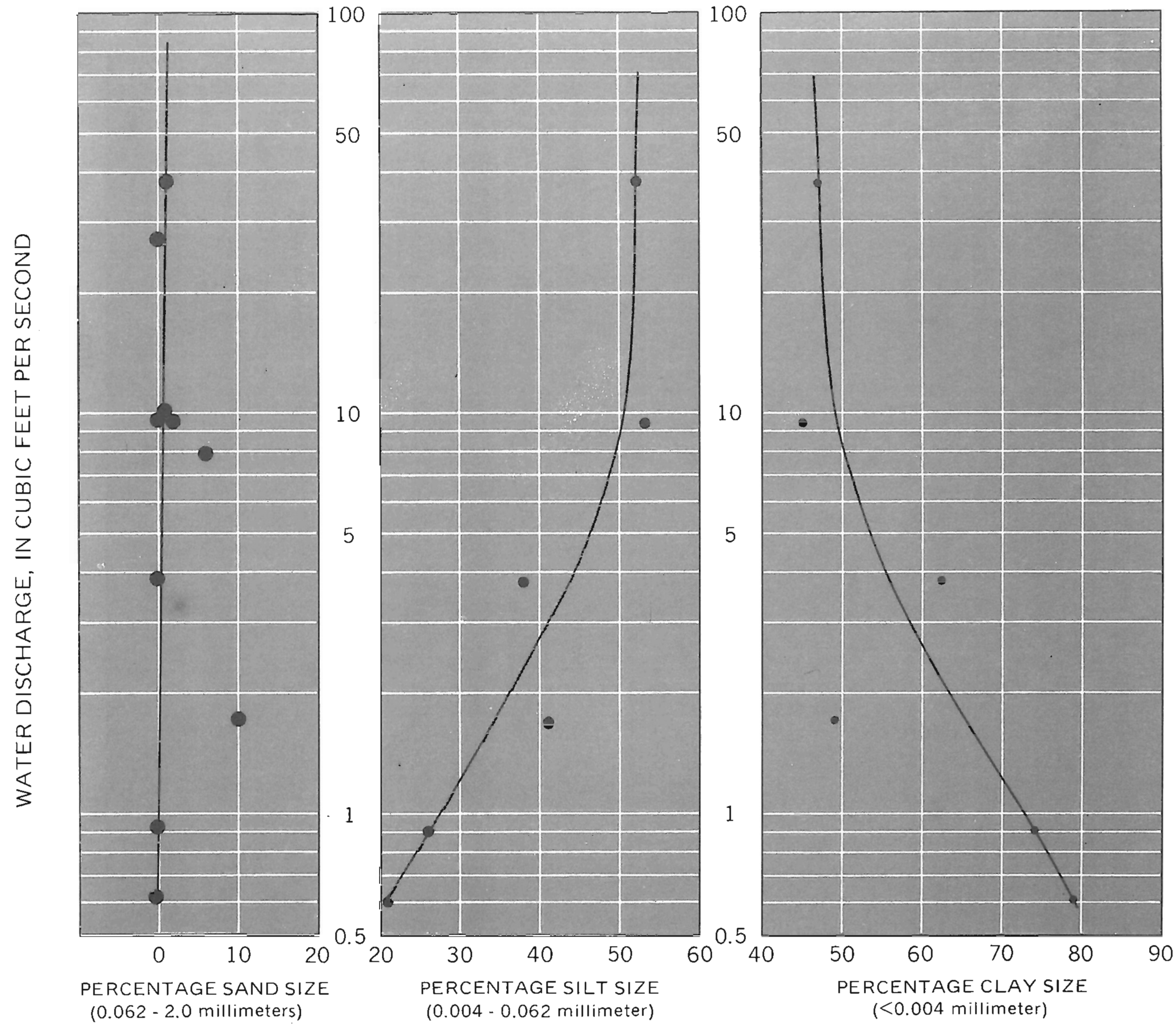

Figure 7. Relation of sand-, silt-, and clay-size fractions of suspended sediment to water discharge, Spring Creek tributary near Rockford, 1980-1981.

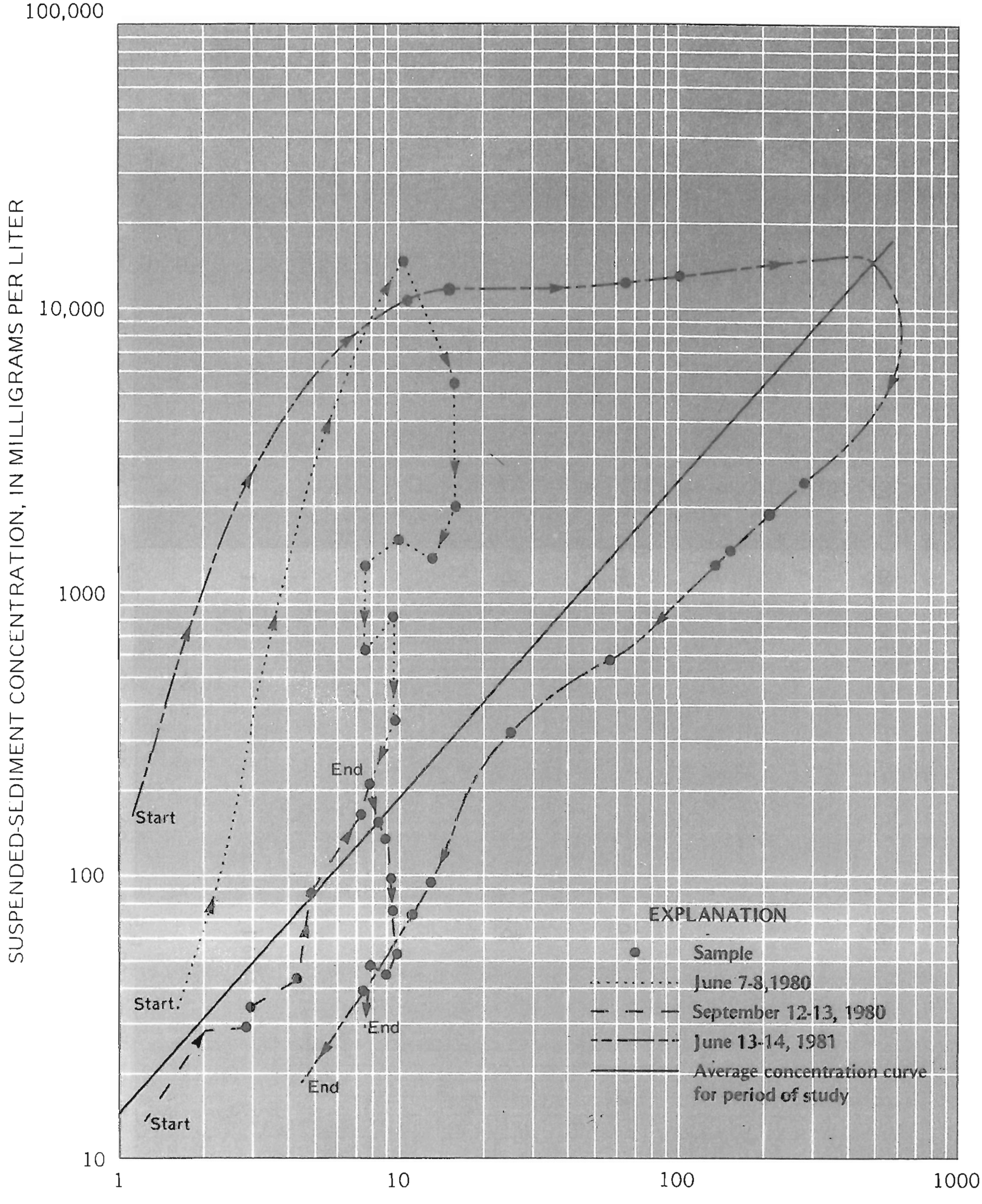

Figure 8. Relation of suspended-sediment concentration to water discharge for storms of June 7-8,1980, September 12-13, 1980, and June 13-14, 1981, Spring Creek at Rock Valley College, Rockford.

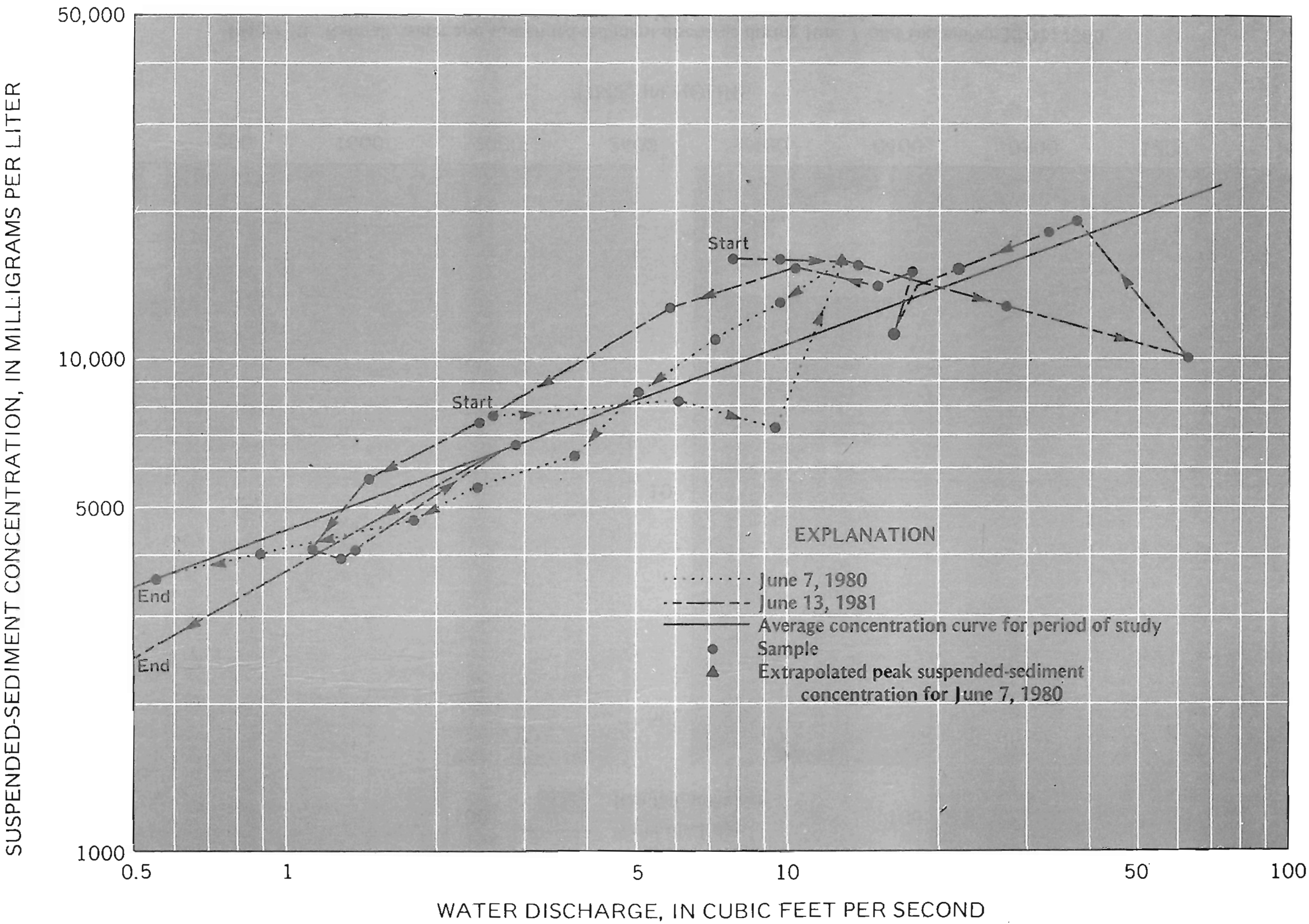

Figure 9. Relation of suspended-sediment concentration to water discharge for storms of June 7, 1980, and June 13, 1981, Spring Creek tributary near Rockford.

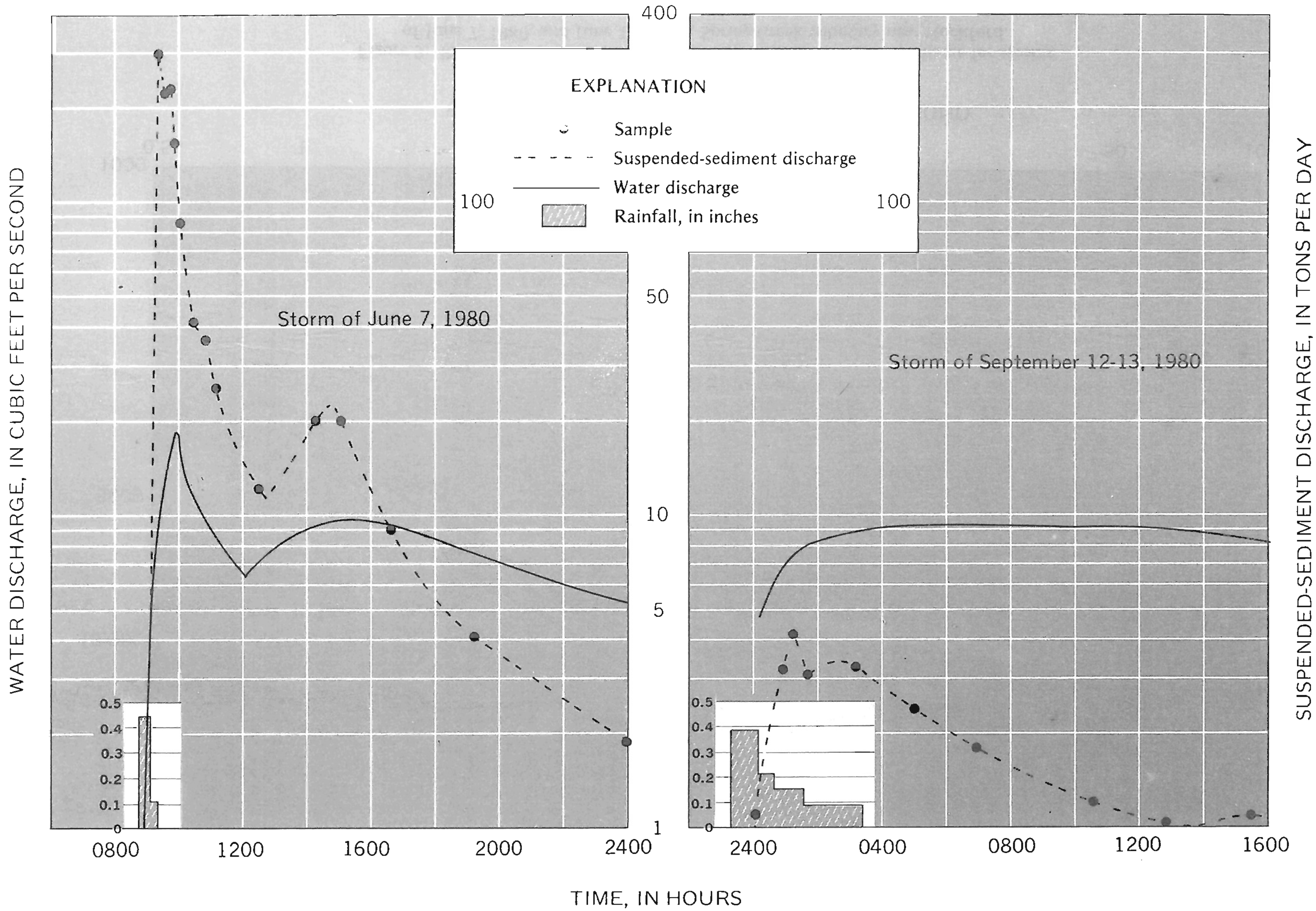

Figure 10. Rainfall, water and suspended-sediment discharge during June 7 and September 12-13, 1980, Spring Creek at Rock Valley College, Rockford.

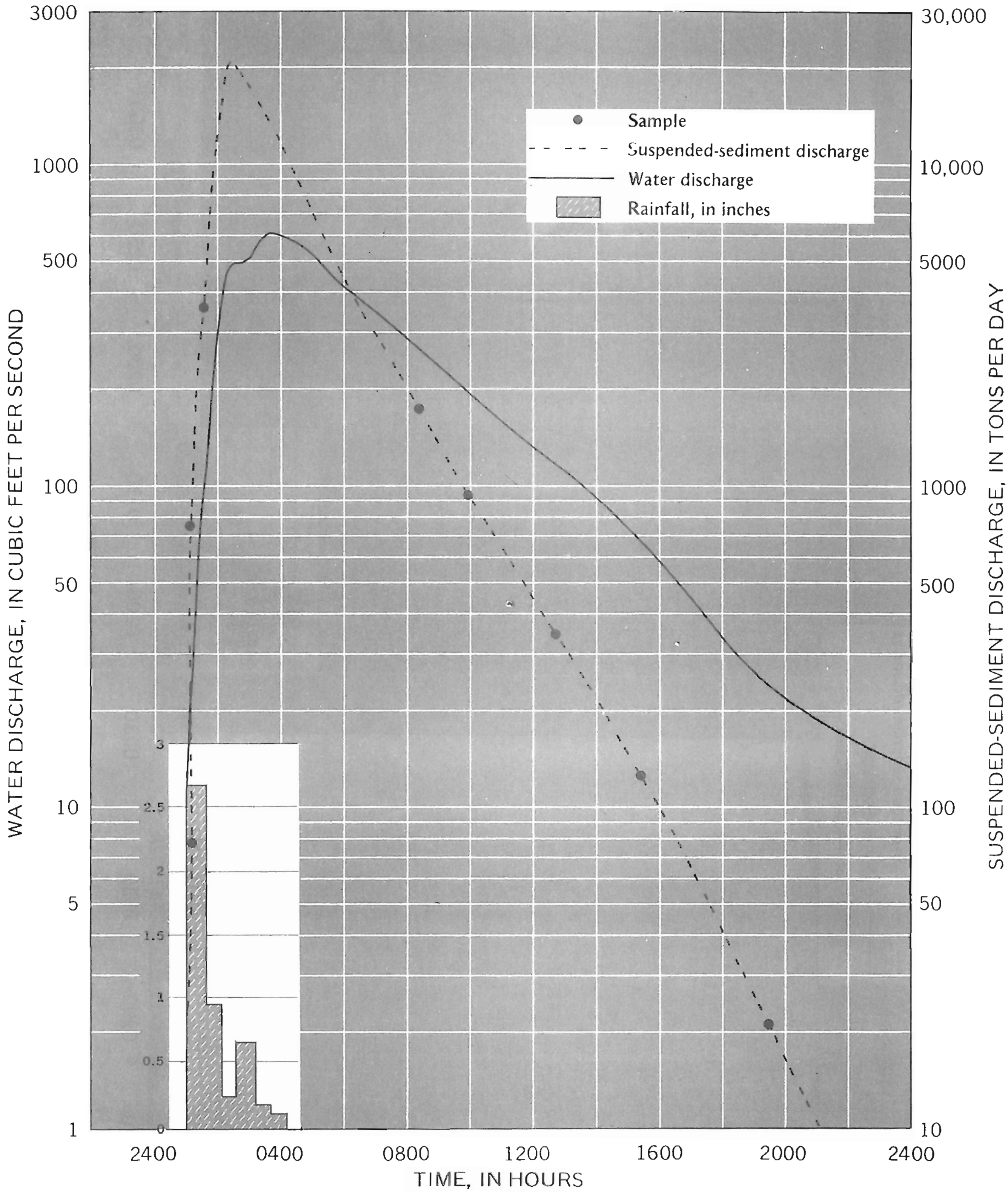

Figure 11. Rainfall, water and suspended-sediment discharge during June 13, 1981, Spring Creek at Rock Valley College, Rockford.

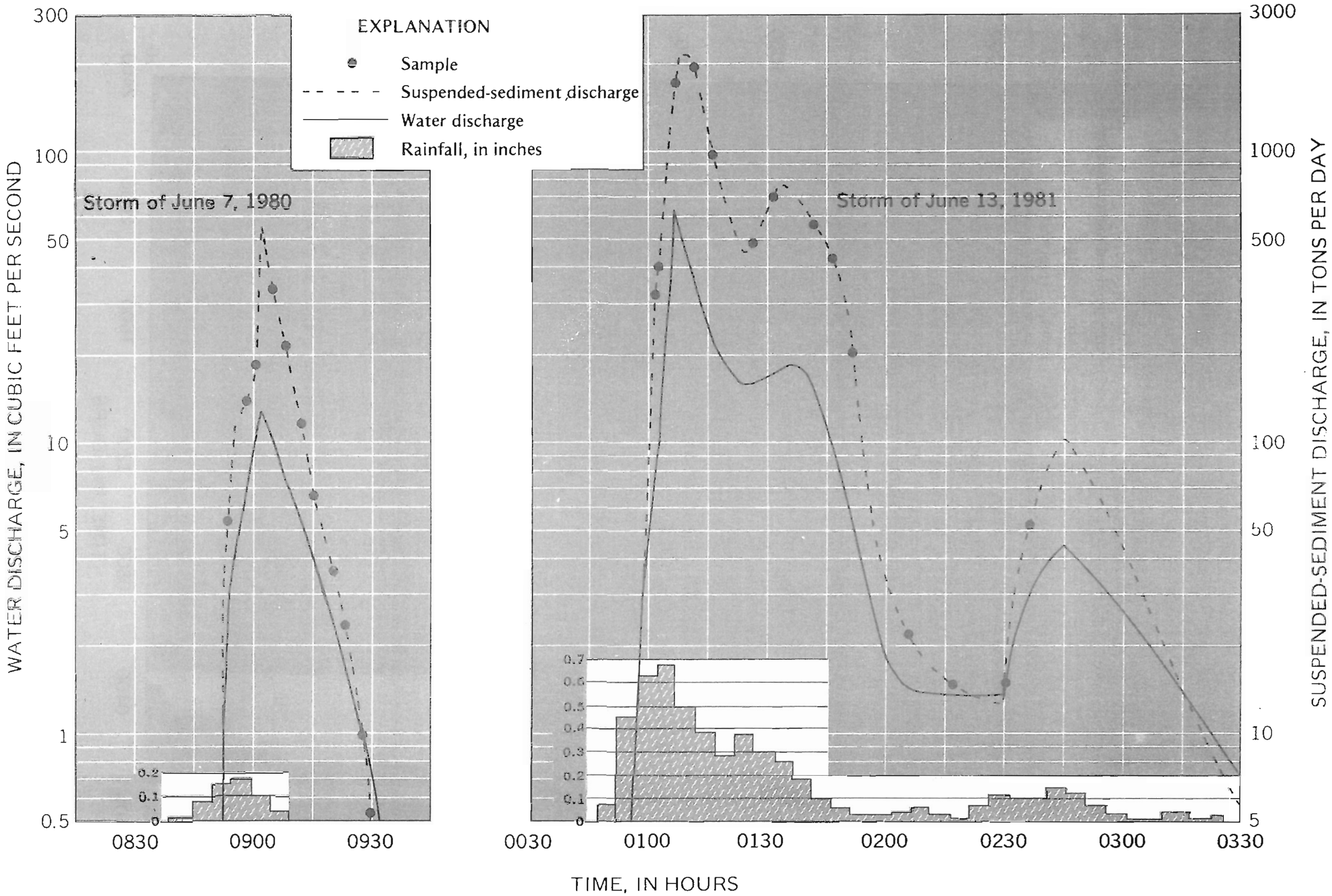

Figure 12. Rainfall, water and suspended-sediment discharge during June 7, 1980, and June 13, 1981, Spring Creek tributary near Rockford.

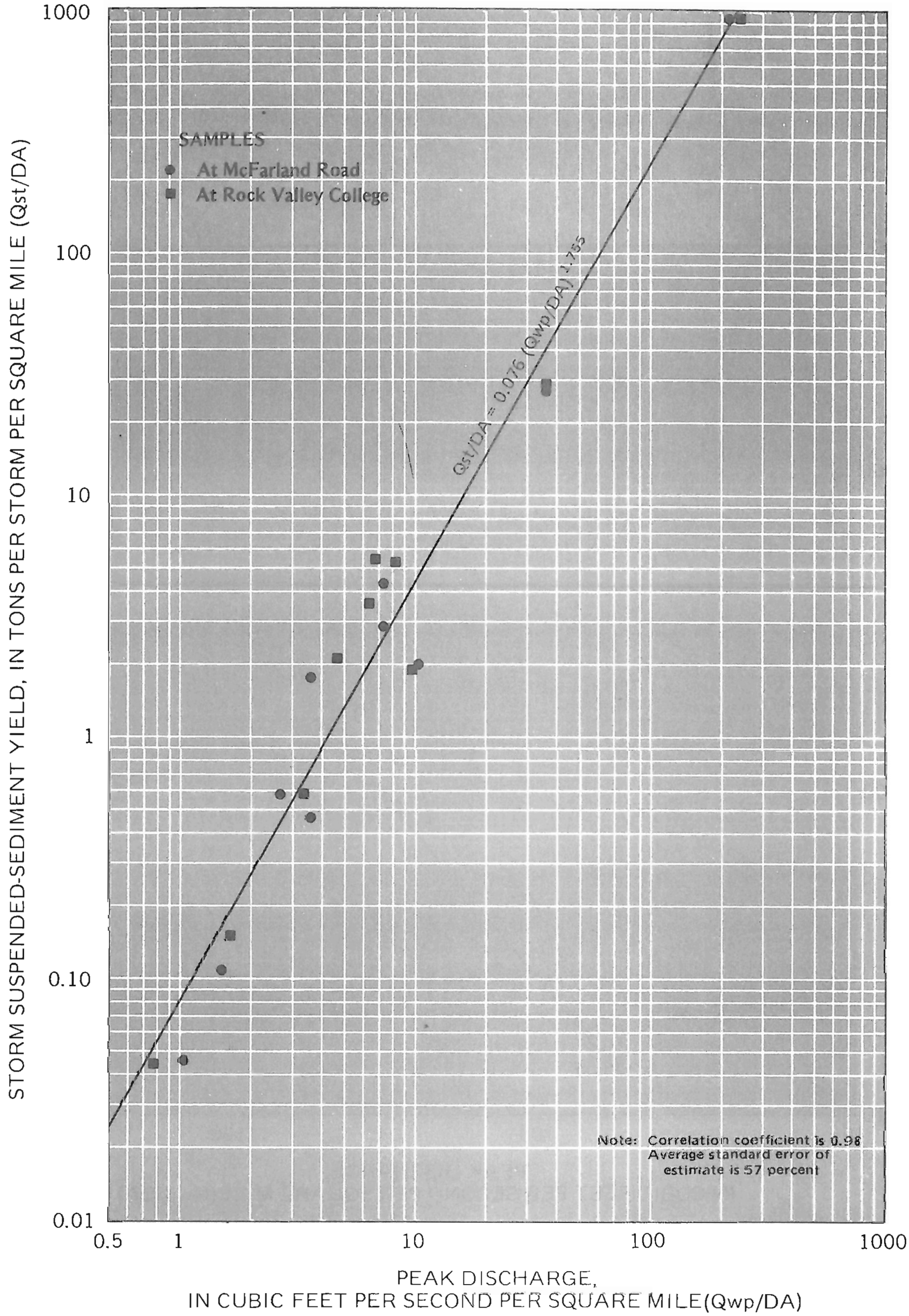

Figure 13. Relation between peak discharge per square mile and storm suspended-sediment yield per square mile for Spring Creek at Rock Valley College and McFarland Road, July 1979 through June 1981.

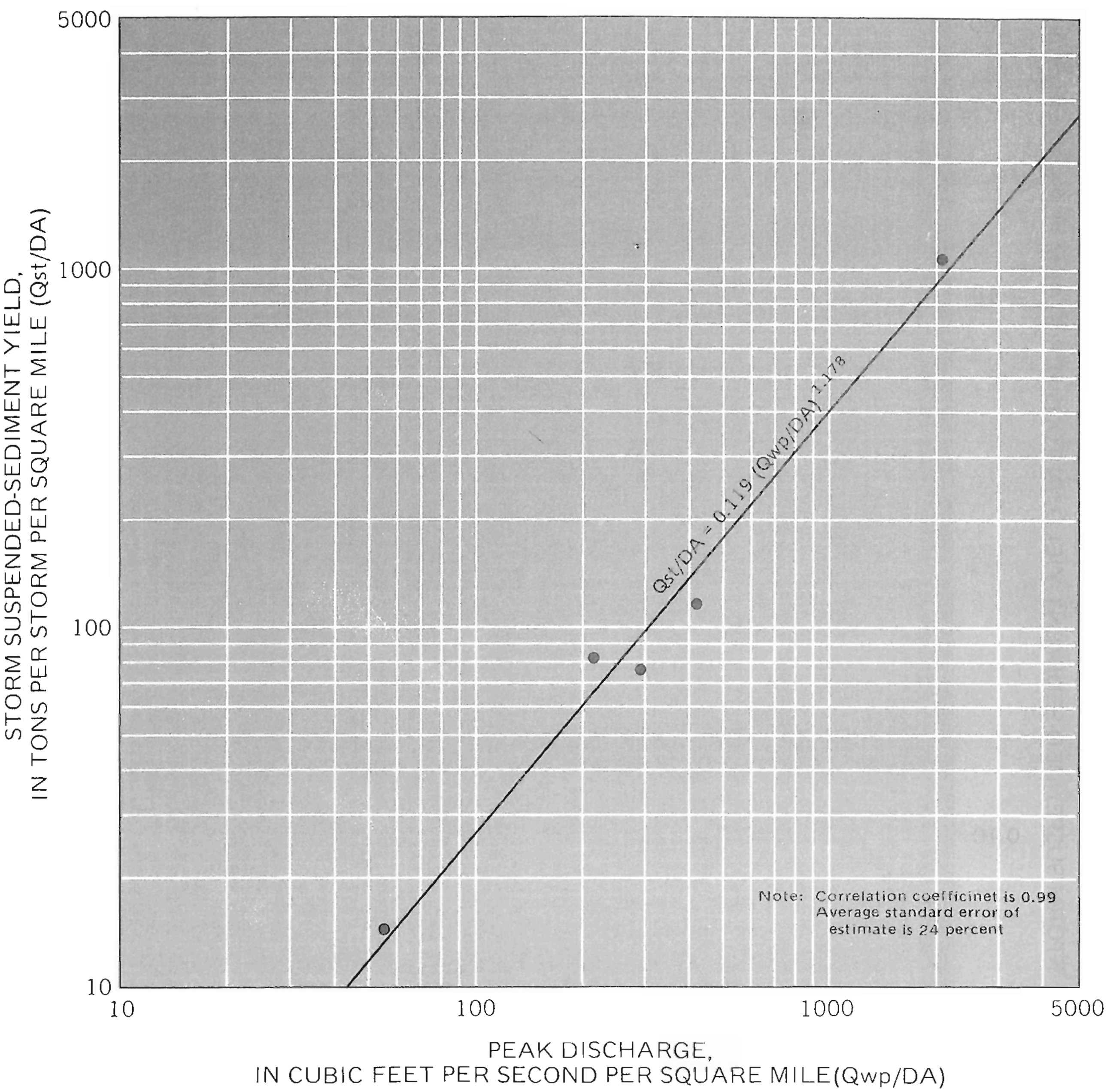

Figure 14. Relation between peak discharge per square mile and storm suspended-sediment yield per square mile for Spring Creek tributary near Rockford, 1980-81.

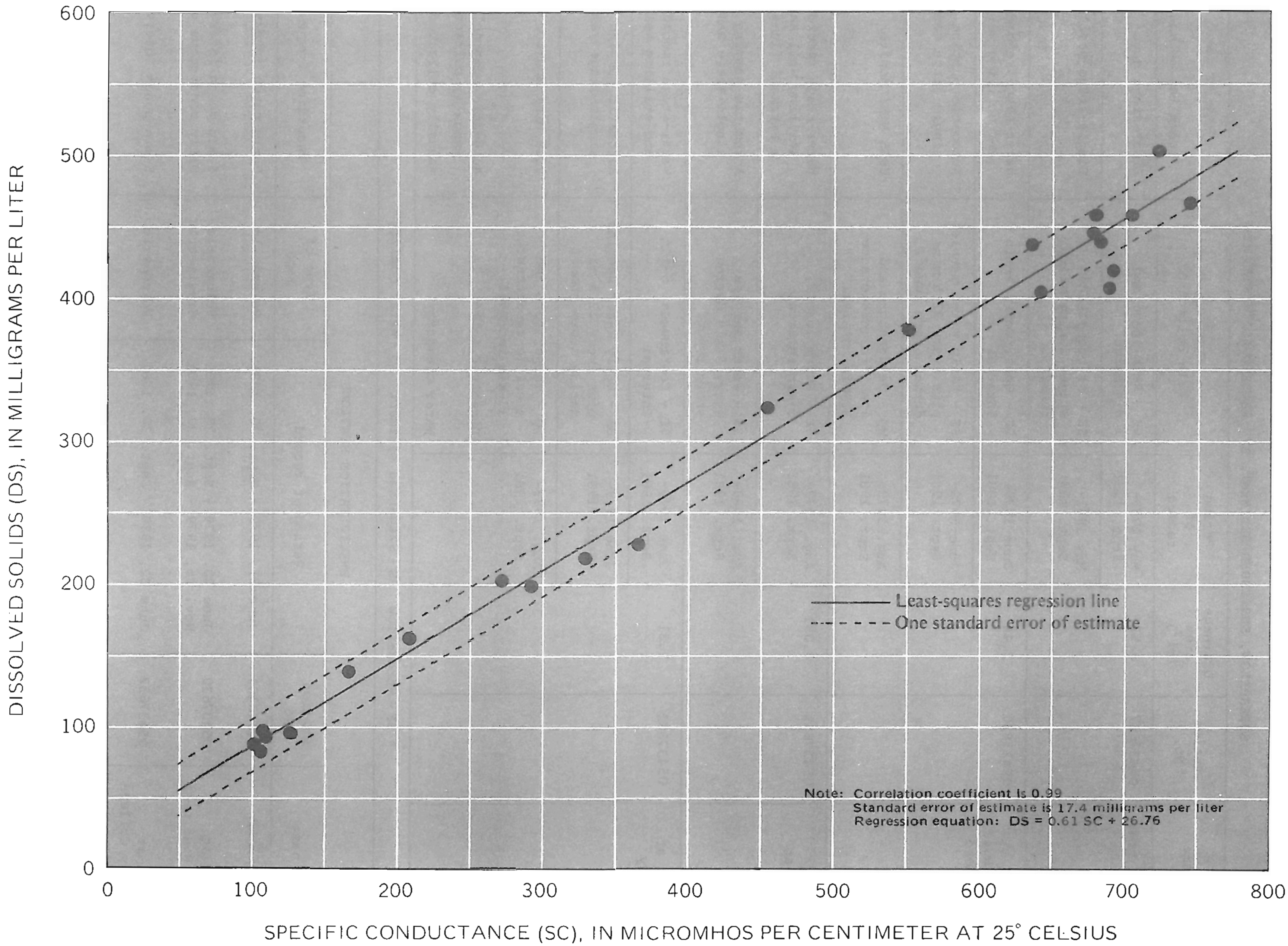

Figure 15. Relation between specific conductance and dissolved solids for Spring Creek at Rock Valley College, Rockford.

STREAMFLOW, SUSPENDED-SEDIMENT, AND WATER-QUALITY STATIONS

Station name	Station No.	Drainage area (mi^2)	Period of record	Type of data collected*	Type of gage or sampling method
Spring Creek near Argyle	05437627	0.93	May 1980- Sept. 1981	SF - Peak stage and discharge	Crest-stage gage
			May 1981- Sept. 1981	SS - At preselected stages during storm runoff	Single-stage samplers
Spring Creek at McFarland Road near Rockford	05437630	2.44	June 1979- Sept. 1981	SF - Continuous, 5-min interval	Water-stage recorder and stilling well
			June 1979- Sept. 1981	SS - Daily water samples plus every 22.5 min during storm runoff	Automatic pumping and single-stage sampler
			Aug. 1979- Sept. 1981	WQ - Temperature and specific conductance, 30-min interval	USGS Mini Monitor
Spring Creek tributary at Rockford	05437631	0.031	Aug. 1979- Sept. 1981	SF - Storm runoff, 5-min interval	Water-stage recorder, stilling well and a Parshall flume
			Apr. 1980- Sept. 1981	SS - Water samples every 5 min during storm runoff	Automatic pumping and single-stage sampler
Spring Creek at Rock Valley College at Rockford	05437632	2.81	June 1979- Sept. 1981	SF - Continuous, 5-min interval	Water-stage recorder and stilling well
			June 1979- Sept. 1981	SS - Daily water samples plus every 22.5 min during storm runoff	Automatic pumping and single-stage sampler
			Aug. 1979- Sept. 1981	WQ - Temperature and specific conductance, 30-min interval	USGS Mini Monitor
				Dissolved solids	Automatic pumping and manually collected
				Water chemistry	Manually collected

* SF - Streamflow SS - Suspended sediment WQ - Water quality

PRECIPITATION STATIONS

Station name	Station No.	Period of record	Type of gage	Recording frequency
Paulson Road near Argyle	88570101	June 21, 1979 - Sept. 30, 1981	Volumetric	5-min punch interval
Spring Creek at McFarland Road near Rockford	05437630	June 20, 1979 - Sept. 30, 1981 Nov. 15, 1979 - Sept. 30, 1981	Volumetric Gravimetric	5-min punch interval Daily continuous chart
Spring Creek at Rock Valley College at Rockford	05437632	June 22, 1979 - Sept. 30, 1981	Volumetric	5-min punch interval

Table 2.--Precipitation in the upper Spring Creek watershed and vicinity, July 1979 through June 1981

Location	Precipitation					
				July 1979 through June 1981		
	1979 6 months (inches)	1980 (inches)	1981 6 months (inches)	Total (inches)	Average (inches per year)	Long-term average (inches per year)
at Rockford Airport (U.S. Weather Service)	17.35	34.17	16.20	67.72	33.86	36.72
at Rock Valley College at Rockford	16.29	31.49	18.12	65.90	32.95	---
at McFarland Road near Rockford	16.43	33.16	18.33	67.92	33.96	---
at Paulson Road near Argyle	15.98	28.66	15.75	60.39	30.20	---
Arithmetic average of the three stations in the study watershed	16.23	31.10	17.40	64.74	32.37	---

Table 3.--Soil erosion potential and soil characteristics* of the upper Spring Creek watershed

Erosion potential	Soil series	USDA soil mapping unit number	Surface material	Parent material	Topography	Slope, in percent	Soil erodi-bility (K-factor)
NONE (Map area No. 1 in fig. 5)	Sable	68	Silty clay loam	Loess or silt sediments	Upland depressions; drainageways; stream terraces	0-2	0.28
	Troxel	197	Silt loam	Silty alluvium	Small drainageways; closed depressions; foot slopes	0-3	.28
	Orion	415	Silt loam	Silty alluvium	Flood plains; foot slopes adjacent to stream terraces	0-2	.37
	Comfrey	776	Loam	Alluvium	Flood plains	0-2	.28
SLIGHT (Map area No. 2 in fig. 5)	Tama	36A	Silt loam	Loess	Upland drainage divides; foot slopes	0-2	0.32
	Muscatine	41	Silt loam	Loess	Upland divides; drainageways; depressions	0-3	.28
	Atterberry	61	Silt loam	Loess	Drainageways on upland plains	0-3	.32
	Hoopeston	172	Sandy loam	Loamy and sandy sediments	Low stream terraces	0-3	.20
	Beardstown	188	Loam	Loamy and sandy sediments	Outwash plains; stream terraces	0-3	.32
	Stronghurst	278	Silt loam	Loess or silty sediments	Upland depressions	0-3	.37
	Rozetta	279A	Silt loam	Loess or silty sediments	Foot slopes	0-3	.37
	Billet	332B	Sandy loam	Loam/sand deposits	Dunal ridges on upland divides	2-6	.20
	Hononegah	354B	Loamy sand	Sandy deposits on sand and gravel	Elevated areas on stream terraces	3-7	.15
	Downs	386A	Silt loam	Loess	Upland divides; side slopes; ridges	0-2	.32
	Flagg	419A	Silt loam	Loess and till	Drainage divides; convex ridge tops	0-2	.37
	Flagler	783A	Sandy loam	Alluvial sediments and sand deposits	Low upland ridges	0-3	.20

Table 3.--Soil erosion potential and soil characteristics* of the upper Spring Creek watershed--Continued

Erosion potential	Soil series	USDA soil mapping unit number	Surface material	Parent material	Topography	Slope, in percent	Soil erodi-bility (K-factor)
MODERATE (Map area No. 3 in fig. 5)	Pecatonica	21B	Silt loam	Loess and paleosol	Upland divides; upper side slopes	2-5	0.37
	Plano	199B	Silt loam	Loess on outwash	Upland divides; side slopes	2-5	.32
	St. Charles	243B	Silt loam	Loess or silty sediments and till	Upland drainage divides	2-5	.37
	Fayette	280B	Silt loam	Loess or silt sediments	Upland ridges; foot slopes	2-5	.37
	Downs	386B	Silt loam	Loess	Upland divides; side slopes	2-6	.32
	Ogle	412B	Silt loam	Loess and till	Ridges; side slopes	2-5	.32
	Flagg	419B	Silt loam	Loess and till	Drainage divides; convex ridge tops	2-5	.37
	Winnebago	728B	Silt loam	Loess and paleosol	Convex ridges	2-5	.32
	Friesland	781B	Sandy loam	Eolian sand	Upper side slopes; ridge tops	2-6	.20
SEVERE (Map area No. 4 in fig. 5)	Pecatonica	21C2	Silt loam	Loess and paleosol	Upland divides; upper side slopes	5-9	0.37
	Westville	22C2	Silt loam	Loess and paleosol	Side slopes	5-9	.37
	Fayette	280C2	Silt loam	Loess or silt sediments	Upland ridges	5-9	.37
	McHenry	310C2	Silt loam	Loess and till	Upland ridges; side slopes along drainageways	5-9	.37
	Flagg	419C2	Silt loam	Loess and till	Drainage divides; convex ridge tops	5-9	.37
VERY SEVERE (Map area No. 5 in fig. 5)	Kidder	361D3	Loam	Loamy glacial till	Side slopes on upland ridges	9-15	0.32

* Information of soil characteristics obtained from the soil survey of Boone and Winnebago Counties, Illinois, U.S. Department of Agriculture, Soil Conservation Service, 1980.

Table 4.--Land use and land cover, in acres, in the upper Spring Creek watershed, 1979

Cultivated fields	Waterways and associated greenways	Grass[1]	Woodlands	Roads[2]	Residential areas
Upper Spring Creek watershed (1,798 acres)					
1,583	51.7	44.6	13.7	23.0	82.0
Spring Creek tributary basin (19.96 acres)[3]					
15.98	0.13	2.73	--	[4]0.59	0.53

[1] Grass areas except those associated with greenways and residential areas.

[2] Impervious road surface area.

[3] The acreage for the tributary basin is included in the totals for the upper Spring Creek watershed.

[4] Abandoned roadway (extension of Trainer Road).

Table 5.--Monthly and annual water and suspended-sediment discharge at the Spring Creek gaging stations, July 1979 through June 1981

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
							(05437630) Spring Creek at McFarland Road near Rockford						
							Water discharge, in cubic feet per second-days						
1979	--	--	--	--	--	--	--	--	--	7.23	76.78	12.02	--
1980	1.47	8.22	24.21	24.98	28.84	26.57	52.65	14.92	52.36	2.81	3.40	56.02	296.45
1981	22.08	11.17	43.52	9.27	89.18	30.63	84.22	35.86	199.60	--	--	--	--
(Mean)	11.78	9.70	33.86	17.12	59.01	28.60	68.43	25.39	125.98	5.02	40.09	34.02	459.00
							Suspended-sediment discharge, in tons per day						
1979	--	--	--	--	--	--	--	--	--	0.79	12.07	1.96	--
1980	0.01	0.27	0.68	0.47	3.40	2.83	2.67	0.55	20.47	0.14	0.22	3.87	35.59
1981	1.00	0.63	3.17	0.22	67.34	1.09	14.52	1.44	2,354.72	--	--	--	--
(Mean)	0.50	0.45	1.92	0.34	35.37	1.96	8.60	1.00	1,187.60	0.46	6.14	2.92	1,247.26
							(05437632) Spring Creek at Rock Valley College at Rockford						
							Water discharge, in cubic feet per second-days						
1979	--	--	--	--	--	--	--	--	--	13.54	101.01	23.45	--
1980	2.47	11.29	32.57	30.55	35.05	32.53	63.16	20.94	58.07	3.73	6.42	65.47	362.25
1981	29.97	13.68	49.00	10.25	99.61	37.77	101.13	42.13	239.22	--	--	--	--
(Mean)	16.22	12.48	40.78	20.40	66.33	35.15	82.14	31.54	148.64	8.64	53.72	44.46	560.50
							Suspended-sediment discharge, in tons per day						
1979	--	--	--	--	--	--	--	--	--	3.46	12.35	0.71	--
1980	0.07	2.54	2.31	1.15	4.27	3.49	2.84	1.29	40.32	0.25	0.30	5.77	64.60
1981	1.33	0.17	5.46	0.22	81.96	1.17	19.77	1.46	2,695.46	--	--	--	--
(Mean)	0.70	1.36	3.88	0.68	43.12	2.33	11.30	1.38	1,367.89	1.86	6.32	3.24	1,444.06

Table 6.--Hydrologic characteristics for storms in upper Spring Creek watershed, July 1979 through June 1981

Period of storm runoff	Total precipitation, Rt (inches)	Maximum 30-minute rainfall intensity, R_{30} (in/h)	Storm runoff duration, D (days)	Antecedent discharge, Qwb (ft^3/s)	Total runoff volume, Qwt [(ft^3/s)•d]	Storm runoff volume, Qwr [(ft^3/s)•d]
	(05437627) Spring Creek near Argyle (Paulson Road)					
June 2, 1980	(a) 0.75	(a) 0.72	--	--	--	--
June 7, 1980	.48	.96	--	--	--	--
June 15, 1980	.83	.52	--	--	--	--
Feb. 22, 1981	2.02	.60	--	--	--	--
Apr. 10, 1981	1.11	.70	--	--	--	--
June 13, 1981	(a) 4.03	(a) 4.00	--	--	--	--
	(05437630) Spring Creek at McFarland Road near Rockford					
Aug. 17-18, 1979	(b) 1.45	(b) 2.52	0.458	0.58	6.84	6.57
June 2-3, 1980	.84	.82	.799	.78	4.01	3.39
June 7-8, 1980	.52	1.05	1.12	1.3	5.80	4.39
June 15, 1980	.90	.68	.695	1.3	6.84	5.96
June 27-28, 1980	.90	1.26	.764	.44	1.13	.79
Sept. 9, 1980	.60	1.21	.778	1.1	2.19	1.36
Sept. 12-13, 1980	.84	.74	1.49	.83	7.63	6.39
Feb. 22-23, 1981	1.80	.49	1.93	2.0	54.1	50.2
Apr. 10-11, 1981	1.22	.79	1.14	2.8	13.4	10.2
June 13-14, 1981	(b) 4.72	(b) 4.84	1.96	.29	161	160

Period of storm runoff	Mean storm discharge, Qwm (ft^3/s)	Peak discharge, Qwp (ft^3/s)	Mean suspended-sediment concentration, Cs (mg/L)	Suspended-sediment yield, Qst (tons/storm)	Suspended-sediment discharge, Qsr (tons/d)
(05437627) Spring Creek near Argyle (Paulson Road)--Continued					
June 2, 1980	--	1.7	--	--	--
June 7, 1980	--	.83	--	--	--
June 15, 1980	--	3.2	--	--	--
Feb. 22, 1981	--	50	--	--	--
Apr. 10, 1981	--	14	--	--	--
June 13, 1981	--	392	5,370*	--	--
(05437630) Spring Creek at McFarland Road near Rockford--Continued					
Aug. 17-18, 1979	14.3	25	272	4.82	10.5
June 2-3, 1980	4.24	6.5	153	1.40	1.75
June 7-8, 1980	3.92	8.9	353	4.19	3.74
June 15, 1980	8.58	18	428	6.89	9.91
June 27-28, 1980	1.03	2.6	52	.11	.14
Sept. 9, 1980	1.75	3.7	71	.26	.33
Sept. 12-13, 1980	4.29	8.9	64	1.11	.63
Feb. 22-23, 1981	26.0	87	488	66.2	34.3
Apr. 10-11, 1981	8.95	18	378	10.4	9.12
June 13-14, 1981	81.6	521	5,414	2,339	1,193

* Discharge weighted based on five samples.
a Paulson Road gage.
b Arithmetic average of Paulson Road and McFarland Road gages.

Table 6.--Hydrologic characteristics for storms in upper Spring Creek watershed, July 1979 through June 1981--Continued

Period of storm runoff	Total precipitation, Rt (inches)	Maximum 30-minute rainfall intensity, R_{30} (in/h)	Storm runoff duration, D (days)	Antecedent discharge, Qwb (ft^3/s)	Total runoff volume, Qwt [(ft^3/s)•d]	Storm runoff volume, Qwr [(ft^3/s)•d]
(05437631) Spring Creek tributary near Rockford						
June 2, 1980	(c) 0.86	(c) 0.86	0.1264	0	0.13	0.13
June 7, 1980	.55	1.10	.0382	0	.14	.14
June 15, 1980	.94	.89	.0694	0	.14	.14
Apr. 10, 1981	1.18	.82	.0867	0	.022	.022
June 13, 1981	(c) 5.42	(c) 5.68	.1321	0	.97	.97
(05437632) Spring Creek at Rock Valley College at Rockford						
Aug. 17-18, 1979	(d) 1.33	(d) 2.30	0.500	0.85	7.33	6.91
June 2-3, 1980	.83	.81	.913	.97	5.34	4.45
June 7-8, 1980	.53	1.05	1.21	1.6	7.61	5.69
June 15, 1980	.90	.70	.691	1.2	7.15	6.29
June 27-28, 1980	.89	1.25	.844	.57	1.34	.86
Sept. 9, 1980	.59	1.18	.861	1.4	3.17	2.02
Sept. 12-13, 1980	.84	.75	1.60	1.1	9.20	7.44
Feb. 22-23, 1981	1.78	.45	2.10	2.0	61.6	57.4
Apr. 10-11, 1981	1.16	.78	1.13	3.4	15.7	11.8
June 13-14, 1981	(d) 4.96	(d) 5.12	1.94	.43	191	190

Period of storm runoff	Mean storm discharge, Qwm (ft^3/s)	Peak discharge, Qwp (ft^3/s)	Mean suspended-sediment concentration, Cs (mg/L)	Suspended sediment yield, Qst (tons/storm)	Suspended-sediment discharge, Qsr (tons/d)
(05437631) Spring Creek tributary near Rockford--Continued					
June 2, 1980	1.03	9.0	6,724	2.36	18.7
June 7, 1980	3.66	13	9,603	3.63	95.0
June 15, 1980	2.02	6.6	6,799	2.57	37.0
Apr. 10, 1981	.25	1.7	7,407	.44	5.07
June 13, 1981	7.35	64	12,944	33.9	257
(05437632) Spring Creek at Rock Valley College at Rockford--Continued					
Aug. 17-18, 1979	13.9	27	282	5.27	10.5
June 2-3, 1980	4.87	13	489	5.87	6.43
June 7-8, 1980	4.70	19	976	15.0	12.4
June 15, 1980	9.10	18	589	10.0	14.5
June 27-28, 1980	1.02	2.2	52	.12	.14
Sept. 9, 1980	2.35	4.7	77	.42	.49
Sept. 12-13, 1980	4.65	9.6	81	1.63	1.02
Feb. 22-23, 1981	27.3	99	521	80.7	38.4
Apr. 10-11, 1981	10.5	23	468	14.9	13.2
June 13-14, 1981	97.9	623	5,246	2,691	1,387

c Arithmetic average of McFarland Road and Rock Valley College gages.
d Arithmetic average of Paulson Road, McFarland Road, and Rock Valley College gages.

Table 7.--Particle-size distribution of suspended sediment in the upper Spring Creek watershed, July 1979 through June 1981

Date	Time	Instantaneous water discharge (ft^3/s)	Suspended-sediment concentration (mg/L)	Suspended-sediment discharge (tons/day)	Percent suspended sediment in size class			
					Sand (0.062-2.0 mm)	Silt (0.004-0.062 mm)	Clay (<0.004 mm)	Silt-clay (<0.062 mm)
			(05437627) Spring Creek near Argyle					
June 13, 1981	(1)	7.6	3,120	64	1	--	--	99
	(1)	55	7,970	1,180	0	--	--	100
	(1)	204	6,340	3,490	0	--	--	100
	0954	61	896	148	0	--	--	100
	1313	11	1,030	31	0	--	--	100
			(05437631) Spring Creek tributary near Rockford					
June 2, 1980	2028	0.90	3,160	7.7	0	26	74	100
	2043	.60	3,000	4.9	0	21	79	100
June 7, 1980	0901	9.5	7,260	186	2	53	45	98
	0916	3.8	6,420	66	0	38	62	100
Apr. 10, 1981	2221	1.7	6,740	31	10	41	49	90
June 13, 1981	0101	7.8	16,100	339	6	--	--	94
	0102*	9.6	16,000	415	0	--	--	100
	0104*	27	12,700	926	0	--	--	100
	0111	38	19,200	1,970	1	52	47	99
	0146	10	15,500	418	1	--	--	99
			(05437632) Spring Creek at Rock Valley College at Rockford					
July 30, 1979	1050	0.82	113	0.25	1	--	--	99
Aug. 18, 1979	0335	22	422	25	4	--	--	96
	0530	20	238	13	2	--	--	98
Aug. 20, 1979	1635	6.9	20	.37	2	--	--	98

Feb. 22, 1980	1310	15	86	3.5	1	--	--	99
June 15, 1980	1235	16	605	26	1	--	--	99
	1450	13	304	11	0	--	--	100
Dec. 8, 1980	1335	7.6	39	.80	1	--	--	99
Feb. 22, 1981	0755	15	608	25	14	--	--	86
	1410	65	842	148	10	--	--	90
Apr. 10, 1981	2315	21	1,420	81	1	33	66	99
June 13, 1981	0128	15	11,500	466	1	--	--	99
	0134	65	11,600	2,040	1	--	--	99
	0140	103	13,100	3,640	1	51	48	99
	0810	284	2,300	1,760	0	26	74	100
	0944	208	1,890	1,060	1	--	--	99
	1135	151	932	380	0	16	84	100
	1504	81	741	162	0	--	--	100
June 14, 1981	0830	11	74	2.2	1	--	--	99

* Concentration from water-sediment sample collected by US U-59 point sampler on the rising phase of hydrograph; time of sample collection determined from plot of stage hydrograph.

1 Concentration from water-sediment sample collected by US U-59 point sampler on the rising phase of hydrograph; time of sample collection unknown.

Table 8.--Summary of suspended-sediment loads transported during storm and nonstorm periods

Station	Period of record	Suspended sediment transported during period of record (tons)			Percentage of suspended sediment transported during periods of storm runoff
		Storm periods	Non-storm periods	Total	
05437630 Spring Creek at McFarland Road near Rockford	July 1979 through June 1981	2,430	60	2,490	97.6
05437631 Spring Creek tributary near Rockford	Aug. 1979 through June 1981	42.9	--	42.9	100
05437632 Spring Creek at Rock Valley College at Rockford	July 1979 through June 1981	2,820	70	2,890	97.6

Table 9.--Suspended-sediment yields by calendar-year quarters for Spring Creek at Rock Valley College at Rockford, July 1979 through June 1981

Calendar year and quarter	Suspended-sediment yields		
	Total (tons)	Tons per square mile ($tons/mi^2$)	Tons per acre (tons/acre)
1979			
July - Sept.	16.52	5.88	0.009
Oct. - Dec.	4.92	1.75	.003
1980			
Jan. - Mar.	8.91	3.17	.005
Apr. - June	44.45	15.82	.025
July - Sept.	6.32	2.25	.004
Oct. - Dec.	6.96	2.48	.004
1981			
Jan. - Mar.	83.35	29.66	.046
Apr. - June	2,716.69	966.79	1.511
Totals	2,888.12	1,027.80	1.607
Quarterly mean			
Jan. - Mar. (1980-81)	46.13	16.42	0.026
Apr. - June (1980-81)	1,380.57	491.31	.768
July - Sept. (1979-80)	11.42	4.06	.006
Oct. - Dec. (1979-80)	5.94	2.11	.003
Cumulative mean	361.02	128.48	0.201

Table 10.--Monthly and annual maximum, minimum, and mean values of water temperature and specific conductance at the Spring Creek gaging stations, August 1979 through June 1981

Water year		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
(05437630) Spring Creek at McFarland Road near Rockford														
Temperature (degrees Celsius) of water														
1979	Max	--	--	--	--	--	--	--	--	--	--	29.0	22.5	--
	Min	--	--	--	--	--	--	--	--	--	--	16.5	9.0	--
	Mean	--	--	--	--	--	--	--	--	--	--	20.0	16.5	--
1980	Max	21.5	13.5	6.5	--	0.5	8.0	19.5	23.0	23.5	32.0	25.0	21.5	32.0
	Min	3.5	1.0	0.0	--	0.0	0.0	4.0	6.0	11.5	14.5	15.0	13.0	0.0
	Mean	12.0	6.0	1.0	--	0.0	1.0	9.5	13.5	16.5	22.0	20.5	17.0	11.5
1981	Max	16.0	8.5	8.0	1.5	6.0	15.0	--	--	--	--	--	--	--
	Min	5.0	0.0	0.0	0.0	0.0	0.0	--	--	--	--	--	--	--
	Mean	10.0	4.5	2.0	0.5	0.5	3.5	--	--	--	--	--	--	--
Specific conductance (micromhos per centimeter at 25° Celsius)														
1979	Max	--	--	--	--	--	--	--	--	--	--	864	741	--
	Min	--	--	--	--	--	--	--	--	--	--	509	655	--
	Mean	--	--	--	--	--	--	--	--	--	--	692	686	--
1980	Max	794	1,110	966	--	1,770	987	899	1,100	1,170	930	1,320	1,330	1,770
	Min	655	515	590	--	271	324	640	573	423	624	545	560	271
	Mean	707	670	662	--	669	675	686	681	717	738	882	824	724
1981	Max	910	840	1,350	790	2,560	990	--	--	--	--	--	--	--
	Min	670	650	600	635	245	630	--	--	75*	--	--	--	--
	Mean	754	767	729	755	795	706	--	--	--	--	--	--	--

(05437632) Spring Creek at Rock Valley College at Rockford

Temperature (degrees Celsius) of water

1979	Max	--	--	--	--	--	--	--	--	--	--	21.0	23.0	--
	Min	--	--	--	--	--	--	--	--	--	--	16.0	8.5	--
	Mean	--	--	--	--	--	--	--	--	--	--	18.5	16.0	--
1980	Max	21.0	12.5	7.0	3.0	0.5	9.5	18.5	21.5	23.5	29.0	25.0	22.0	29.0
	Min	2.0	0.0	0.0	0.0	0.0	0.0	2.5	5.5	11.5	15.0	15.5	12.0	0.0
	Mean	10.5	5.0	1.5	0.5	0.0	3.5	7.5	13.5	16.5	20.5	19.5	16.5	10.5
1981	Max	17.0	10.0	7.5	--	--	14.5	16.5	20.5	24.5	--	--	--	--
	Min	2.0	0.0	0.0	0.0	0.0	0.0	1.5	5.5	14.0	--	--	--	--
	Mean	9.5	4.5	1.0	--	--	4.0	9.5	12.5	18.0	--	--	--	--

Specific conductance (micromhos per centimeter at 25° Celsius)

1979	Max	--	--	--	--	--	--	--	--	--	--	707	708	--
	Min	--	--	--	--	--	--	--	--	--	--	563	657	--
	Mean	--	--	--	--	--	--	--	--	--	--	634	687	--
1980	Max	691	990	901	1,180	719	721	1,460	1,050	1,070	748	1,410	1,270	1,460
	Min	607	531	534	384	624	490	587	590	425	237	410	390	237
	Mean	662	660	646	654	688	632	690	678	708	686	815	793	696
1981	Max	870	735	1,100	--	--	857	810	850	749	--	--	--	--
	Min	650	660	585	--	--	628	310	640	65	--	--	--	--
	Mean	727	702	704	--	--	686	657	699	673	--	--	--	--

* Minimum observed value.

Table 11.--Chemical analyses of streambed material and water samples from the upper Spring Creek watershed

Streambed material analyses

Date	Nitrite + nitrate, total (mg/kg as N)	Nitrogen, ammonia (mg/kg as N)	Nitrogen, ammonia + organic (mg/kg as N)	Phosphorus, total (mg/kg as P)	Arsenic, total (µg/g)	Cadmium, total (µg/g)
	100-190 feet upstream from Interstate Highway 90					
May 7, 1980	5.9	23	22,800	760	3	<1.0
	840-1,010 feet downstream from Interstate Highway 90					
May 7, 1980	12	35	11,700	9.0	2	<10
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.					
May 16, 1979	1.7	38	6,600	490	0	<10
May 7, 1980	11	30	6,900	630	2	<10
	(05437632) Spring Creek at Rock Valley College at Rockford, Ill.					
May 15, 1979	2.6	38	5,600	350	0	<10
May 7, 1980	6.0	15	6,800	260	1	<10

Date	Mercury, total (µg/g)	Zinc, total (µg/g)	Carbon, organic (g/kg as C)	Carbon, inorganic (g/kg as C)	Oil and grease, total (mg/kg)	PCB (µg/kg)
	100-190 feet upstream from Interstate Highway 90					
May 7, 1980	0.0	60	40	0.2	0	--
	840-1,010 feet downstream from Interstate Highway 90					
May 7, 1980	0.0	60	34	1.0	0	--
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.					
May 16, 1979	0.0	40	20	1.1	0	0
May 7, 1980	0.0	40	26	2.2	0	--
	(05437632) Spring Creek at Rock Valley College at Rockford, Ill.					
May 15, 1979	0.0	30	27	2.5	0	3
May 7, 1980	0.0	28	23	2.0	0	--

Date	Ethion (µg/kg)	Heptachlor epoxide (µg/kg)	Heptachlor (µg/kg)	Lindane (µg/kg)	Malathion (µg/kg)	Mirex (µg/kg)
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.					
May 16, 1979	0.0	0.0	0.0	0.0	0.0	0.0
	(05437632) Spring Creek at Rock Valley College at Rockford, Ill.					
May 15, 1979	0.0	0.0	0.0	0.0	0.0	0.0

Table 11.--Chemical analyses of streambed material and water samples from the upper Spring Creek watershed--Continued

Streambed material analyses--Continued

Date	Chromium, total (µg/g)	Cobalt, total (µg/g)	Copper, total (µg/g)	Iron, total (µg/g)	Lead, total (µg/g)	Manganese, total (µg/g)
	100-190 feet upstream from Interstate Highway 90					
May 7, 1980	10	20	20	9,700	30	420
	840-1,010 feet downstream from Interstate Highway 90					
May 7, 1980	10	20	20	10,000	20	540
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.					
May 16, 1979	10	10	<10	9,000	10	150
May 7, 1980	<10	<10	<10	6,100	<10	190
	(05437632) Spring Creek at Rock Valley College at Rockford, Ill.					
May 15, 1979	<10	<10	<10	6,800	<10	80
May 7, 1980	<10	<10	<10	5,000	20	130

Date	Aldrin (µg/kg)	DDD (µg/kg)	DDE (µg/kg)	DDT (µg/kg)	Diazinon (µg/kg)	Deildrin (µg/kg)
	100-190 feet upstream from Interstate Highway 90					
May 7, 1980	--	--	--	--	--	--
	840-1,010 feet downstream from Interstate Highway 90					
May 7, 1980	--	--	--	--	--	--
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.					
May 16, 1979	0.9	0.5	0.2	0.0	0.0	6.0
May 7, 1980	--	--	--	--	--	--
	(05437632) Spring Creek at Rock Valley College at Rockford, Ill.					
May 15, 1979	0.0	0.0	0.3	1.2	0.0	15
May 7, 1980	--	--	--	--	--	--

Date	Toxaphene (µg/kg)	2,4-D (µg/kg)	2,4,5-T (µg/kg)	Silvex (µg/kg)
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.			
May 16, 1979	0	0	0	0
	(05437632) Spring Creek at Rock Valley College at Rockford, Ill.			
May 15, 1979	0	0	0	0

Table 11.--Chemical analyses of streambed material and water samples from the upper Spring Creek watershed--Continued

Water quality analyses

Date	Time	Streamflow, instantaneous (ft^3/s)	Specific conductance (micromhos per centimeter at 25°C)	pH (units)	Temperature (deg C)	Solids, residue at 180 deg. C dissolved (mg/L)
	(05437630)	Spring Creek at McFarland Road near Rockford, Ill.				
Apr. 26, 1979	1045	20	234	7.2	10.0	176
	(05437632)	Spring Creek at Rock Valley College at Rockford, Ill.				
Apr. 26, 1979	1210	30	291	7.4	12.5	200
Apr. 11, 1981	0030	17	366	7.9	12.5	230
Apr. 13, 1981	2035	6.0	640	8.3	12.6	404
Apr. 16, 1981	2100	4.2	634	8.5	13.2	436
May 14, 1981	1525	1.7	675	8.4	9.0	444
May 18, 1981	0400	1.3	701	8.3	9.0	457
May 24, 1981	0405	1.1	684	8.3	15.2	419
May 27, 1981	0225	.86	687	8.3	15.0	406
June 1, 1981	1315	.75	680	8.3	18.6	439
June 13, 1981	1057	168	104	6.5	19.5	89
June 13, 1981	1110	160	108	6.6	19.5	84
June 13, 1981	1130	150	109	6.6	20.0	98
June 13, 1981	1158	138	113	6.6	20.4	94
June 13, 1981	1207	135	130	6.8	20.5	98
June 13, 1981	1540	68	168	6.7	23.0	140
June 13, 1981	1709	47	210	6.7	24.2	162
June 13, 1981	1855	28	272	6.9	24.4	203
June 13, 1981	2025	20	328	6.9	24.0	219
June 14, 1981	0055	14	452	7.2	21.8	322
June 14, 1981	0904	10	550	7.3	20.0	377
June 26, 1981	1235	2.0	740	7.9	18.0	465
July 2, 1981	1135	1.0	720	8.0	19.6	502

Date	Time	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Alkalinity (mg/L as $CaCO_3$)
	(05437630)	Spring Creek at McFarland Road near Rockford, Ill.				
Apr. 26, 1979	1045	21	9.5	6.8	5.0	48
	(05437632)	Spring Creek at Rock Valley College at Rockford, Ill.				
Apr. 26, 1979	1210	27	10	7.8	4.4	71
June 13, 1981	1207	11	--	1.8	3.9	21

Date	Time	Solids, non-volatile, suspended (mg/L)	Solids, volatile, suspended (mg/L)	Nitrogen, nitrate total (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrite total (mg/L as N)
	(05437630)	Spring Creek at McFarland Road near Rockford, Ill.				
Apr. 26, 1979	1045	192	26	--	4.7	--
	(05437632)	Spring Creek at Rock Valley College at Rockford, Ill.				
Apr. 26, 1979	1210	3,510	34	--	5.9	--
June 13, 1981	1207	--	--	0.80	0.96	0.17

Table 11.--Chemical analyses of streambed material and water samples from the upper Spring Creek watershed--Continued

Water quality analyses--Continued

Date	Solids, residue at 105 deg. C suspended (mg/L)	Oxygen demand, chemical (high level) (mg/L)	Coliform, fecal, 0.7 um-mf (cols./ 100 mL)	Strep-tococci, fecal, kf agar (cols./ 100 mL)	Hardness (mg/L as $CaCO_3$)	Hardness, noncar-bonate (mg/L as $CaCO_3$)
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.					
Apr. 26, 1979	218	--	K14,000	K1,300,000	92	44
	(05437632) Spring Creek at Rock Valley College at Rockford, Ill.					
Apr. 26, 1979	3,540	--	K15,000	K840,000	120	46
Apr. 11, 1981	--	--	--	--	--	--
Apr. 13, 1981	--	--	--	--	--	--
Apr. 16, 1981	--	--	--	--	--	--
May 14, 1981	--	--	--	--	--	--
May 18, 1981	--	--	--	--	--	--
May 24, 1981	--	--	--	--	--	--
May 27, 1981	--	--	--	--	--	--
June 1, 1981	--	--	--	--	--	--
June 13, 1981	--	--	--	--	--	--
June 13, 1981	--	--	--	--	--	--
June 13, 1981	--	--	--	--	--	--
June 13, 1981	--	--	--	--	--	--
June 13, 1981	1,430	130	--	--	46	25
June 13, 1981	--	--	--	--	--	--
June 13, 1981	--	--	--	--	--	--
June 13, 1981	--	--	--	--	--	--
June 13, 1981	--	--	--	--	--	--
June 14, 1981	--	--	--	--	--	--
June 14, 1981	--	--	--	--	--	--
June 26, 1981	--	--	--	--	--	--
July 2, 1981	--	--	--	--	--	--

Date	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L as $SiSO_2$)	Turbidity (ntu)	Oxygen, dissolved (mg/L)
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.					
Apr. 26, 1979	15	18	0.2	9.8	150	8.3
	(05437632) Spring Creek at Rock Valley College at Rockford, Ill.					
Apr. 26, 1979	18	20	0.2	9.8	150	8.6
June 13, 1981	6.2	5.8	--	--	--	--

Date	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, organic total (mg/L as N)	Nitrogen, organic dissolved (mg/L as N)	Nitrogen, total (mg/L as N)
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.					
Apr. 26, 1979	0.06	0.47	0.23	1.7	0.71	7.2
	(05437632) Spring Creek at Rock Valley College at Rockford, Ill.					
Apr. 26, 1979	0.05	0.35	0.16	1.6	0.51	7.8
June 13, 1981	0.04	0.66	0.15	2.6	0.73	4.3

K Results based on colony count outside the acceptable range (non-ideal colony count).

Table 11.--Chemical analyses of streambed material and water samples from the upper Spring Creek watershed--Continued

Water quality analyses--Continued

Date	Time	Nitrogen, dissolved (mg/L as N)	Phosphorus, total (mg/L as P)	Phosphorus, dissolved (mg/L as P)	Arsenic, total (µg/L)	Arsenic, dissolved (µg/L)
	(05437630)	Spring Creek at McFarland Road near Rockford, Ill.				
Apr. 26, 1979	1045	5.7	0.99	0.61	3	2
	(05437632)	Spring Creek at Rock Valley College at Rockford, Ill.				
Apr. 26, 1979	1210	6.6	2.4	0.49	2	2
June 13, 1981	1207	1.9	1.9	0.43	--	--

Date	Time	Cobalt, dissolved (µg/L)	Copper, total recoverable (µg/L)	Copper, dissolved (µg/L)	Iron, total recoverable (µg/L)	Iron, dissolved (µg/L
	(05437630)	Spring Creek at McFarland Road near Rockford, Ill.				
Apr. 26, 1979	1045	1	16	3	17,000	370
	(05437632)	Spring Creek at Rock Valley College at Rockford, Ill.				
Apr. 26, 1979	1210	1	11	2	12,000	100
June 13, 1981	1207	--	27	0	25,000	770

Date	Time	Selenium, total (µg/L)	Silver, total recoverable (µg/L)	Zinc, total recoverable (µg/L)	Zinc, dissolved (µg/L)	Carbon, organic total (mg/L as C)
	(05437630)	Spring Creek at McFarland Road near Rockford, Ill.				
Apr. 26, 1979	1045	0	0	160	10	18
	(05437632)	Spring Creek at Rock Valley College at Rockford, Ill.				
Apr. 26, 1979	1210	0	0	150	0	--
June 13, 1981	1207	--	--	130	8	45

Table 11.--Chemical analyses of streambed material and water samples from the upper Spring Creek watershed--Continued

Water quality analyses--Continued

Date	Barium, total recoverable (µg/L)	Barium, dissolved (µg/L)	Cadmium, total recoverable (µg/L)	Chromium, total recoverable (µg/L)	Chromium, dissolved (µg/L)	Cobalt, total recoverable (µg/L)
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.					
Apr. 26, 1979	200	100	0	70	30	5
	(05437632) Spring Creek at Rock Valley College near Rockford, Ill.					
Apr. 26, 1979	200	100	0	30	20	3
June 13, 1981	--	--	--	--	--	--

Date	Lead, total recoverable (µg/L)	Lead, dissolved (µg/L)	Manganese, total recoverable (µg/L)	Manganese, dissolved (µg/L)	Mercury, total recoverable (µg/L)	Mercury, dissolved (µg/L)
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.					
Apr. 26, 1979	7	3	370	30	0.8	0.5
	(05437632) Spring Creek at Rock Valley College near Rockford, Ill.					
Apr. 26, 1979	8	4	220	10	0.8	0.5
June 13, 1981	39	0	--	4.6	--	--

Date	Carbon, organic dissolved (mg/L as C)	Carbon, organic suspended total (mg/L as C)	Oil and grease, total recov. gravimetric (mg/L)
	(05437630) Spring Creek at McFarland Road near Rockford, Ill.		
Apr. 26, 1979	9.1	8.6	0.0
	(05437632) Spring Creek at Rock Valley College at Rockford, Ill.		
Apr. 26, 1979	13	4.3	0.0
June 13, 1981	4.7	--	--

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